



**ATTACHMENT Z-1**  
**ENVIRO-CHEM CORPORATION SUPERFUND SITE**  
**ZIONSVILLE, INDIANA**

Submitted to:

U.S. Environmental Protection Agency, Region 5  
And  
Indiana Department of Environmental Management

Submitted by:

ENVIRON International Corporation  
Deerfield, Illinois

On behalf of:

The ECC Site Trustees

June 2005

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## 1.0 INTRODUCTION

As presently configured, the soil vapor extraction (SVE) system that has been installed at the Enviro-Chem Corporation Superfund Site ("ECC" or "Site") has not achieved the subsurface water cleanup standards in the till set forth in Table 3-1 to Revised Exhibit A (incorporated herein as Table Z-1-1). United States Environmental Protection Agency (USEPA) and Indiana Department of Environmental Management (IDEM) are concerned that failure to achieve those cleanup standards may, over time, have an adverse effect on water quality in Unnamed Ditch, which is located adjacent to the eastern portion of the Site. For that reason, the Consent Decree and the amended ROD provide for specific Additional Work to be performed if USEPA determines that those standards were not met within a five-year period, unless the parties agree otherwise.

These standards were not met within the five-year period provided in the Consent Decree, and this attachment describes agreed modifications to the "Additional Work" provisions of the Consent Decree. In particular, the existing SVE system will be augmented by additional trenches provided for in Attachment Z-1 to be installed generally along the alignment previously required in Revised Exhibit A to the Consent Decree for "Additional Work." The new SVE trenches will be connected to the existing SVE system and will be operated using all of the basic operations of the existing SVE system. In order to provide additional protection to Unnamed Ditch, a barrier wall and reactive gate will also be constructed. The work required under Attachment Z-1 enhances and replaces the water interception trench originally required as the Additional Work in Revised Exhibit A and all Attachment Z-1 work will be conducted under the Additional Work provisions of the Consent Decree, as amended.

After completion of construction, there will be several distinct phases for the operation of the modified Additional Work. The activities will be different for each period. The periods and the associated activities are as follows:



- A. Active Phase: This is defined as the period of operation of the augmented SVE trench system.
- B. Phase I Long Term Monitoring: This is defined as the five-year period beginning when the Soil Vapor Standards have been achieved in the augmented SVE trenches. At the completion of the Phase I Long Term Monitoring period, Phase II Long Term Monitoring will begin at the Site.
- C. Phase II Long Term Monitoring: This is defined as the period following the completion of Phase I Long Term Monitoring.

## **2.0 AUGMENTATION OF SVE SYSTEM – REMEDIAL ACTIONS**

The primary objective of the modified Additional Work is to treat subsurface water and soil contamination in the vicinity of the augmented SVE trench system and prevent off-site migration of contaminated subsurface water to Unnamed Ditch.

The sequence of activities for implementing the modified Additional Work is presented below.

- Installation of SVE trenches along the east, south, and southwest sides of the ECC Site.
- Installation of a thin barrier curtain wall along the east, south, and southwest sides of the ECC Site adjacent to and near the outside edge of the trenches.
- Collection and treatment of subsurface water in the till and extraction of soil vapors via the augmented SVE trench system until attainment of Soil Vapor Standards.
- Monitoring of surface and subsurface water.
- Control of the Site hydraulic gradient within the till unit and further assurance of protection of Unnamed Ditch from the discharge of contamination above Acceptable Stream Concentrations in Table Z-1-1 using a permeable reactive gate system (PRGS).

Modified Additional Work activities, including the surface and subsurface water monitoring, are discussed in more detail in the following sections.

### **2.1 Well Abandonment**

Prior to the construction of the augmented SVE trench system, all wells that have the potential for interference with the construction or operation of the augmented SVE trench system will be abandoned. The wells that will be abandoned are T-6, T-7, T-8, T-9, S-2, S-3, MW13, HT-1, CDW-1, CDW-2,<sup>1</sup> HS-1, HS-1A, HS-2, IW-5, and

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<sup>1</sup> Construction dewatering wells located in the northeast portion of the former Southern Concrete Pad Area (SCPA).

piezometer P-1. In addition, well S-4A will be abandoned following the construction of its replacement well S-4B.<sup>2</sup> Figure 1 shows the locations of the wells to be abandoned.

The wells will be abandoned by removing the stickup protective casing (if present) and tremie grouting the well, from the bottom, with a bentonite/cement grout. The outer protective well casing will be removed and the inner polyvinyl chloride (PVC) well casing will be cut to a depth of at least two feet below ground surface (bgs). The well screen and casing will then be tremie-grouted with a bentonite/cement mixture to within six inches of the ground surface, and the surface will be filled with soil or gravel, as appropriate. A detailed description of the well abandonment methodology will be presented in the design report.

Within 30 days of the completion of the abandonment, the Indiana Department of Natural Resources – Division of Water will be notified in writing of the identification and location of the wells, and the procedures followed during the abandonment. The USEPA and IDEM will be copied on this notification.

## **2.2 Augmented SVE Trench System**

The augmented SVE trench system will be used for SVE treatment of the shallow till along the east, south, and southwest sides of the Site. The existing SVE system will be augmented by additional trenches and the new trenches will be connected to the existing SVE system and will be operated using the nine basic operations of the existing SVE system. The nine basic operations are as follows:

1. Aeration and equalization of “raw water” within tank T-2.
2. Transfer of the water to the treatment building using influent feed pumps.
3. Filtration of the influent water using total suspended solids (TSS) filters.
4. Treatment using counter-current tray aeration air stripper.
5. Combining the air stripper “off-gas” with the SVE “air header pipe.”

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<sup>2</sup> Construction related activities conducted at the ECC Site during 1998 and 1999 may have damaged monitoring well S-4A. As a result, a new well (S-4B) will be installed approximately 50 feet to the south (downgradient) of S-4A in a low-traffic area to be agreed on by the parties.

6. Absorption of organics in the combined air stream using granular activated carbon prior to release to the atmosphere.
7. Filtration of air stripper effluent water through additional TSS filters.
8. Absorption of residual organics in the filtered air stripper effluent water using granular activated carbon.
9. Discharge of treated water to Unnamed Ditch.

### **2.2.1 The SVE Process – SVE Trenches**

The SVE process takes advantage of the volatility of the contaminants to allow the mass transfer of volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) from adsorbed, dissolved, and free phases in the soil to the vapor phase, where it is removed under vacuum pressure. The basic operation for the ECC Site includes the extraction of air and water from the trench system. The SVE system dries any sand lenses within the zone of influence of the SVE system.<sup>3</sup> Contaminated moisture in the sand lenses is likely to be the principal mechanism by which contamination is transmitted to the trenches. The SVE system is expected to remove that moisture. Free liquid entrained in the air will be removed by gravity in an entrainment separator. Periodically, water that accumulates in the entrainment separator will be pumped to an on-site storage tank for subsequent treatment, as needed, and then to an on-site discharge point in accordance with the substantive requirements of applicable federal and state laws as well as the Applicable or Relevant and Appropriate Requirements (ARARs). Vacuum pumps will also be used for the collection of contaminants via soil vapors. From the vacuum pumps, the collected vapor will pass through the existing carbon adsorption system, which consists of carbon columns connected in series. Appendix A contains a more detailed description of the on-site treatment system.

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<sup>3</sup> The zone of influence from the augmented SVE trench system will not reach contamination over the entire site, but should capture and destroy the most mobile contaminants located in closest proximity to Unnamed Ditch.

### **2.2.2 Augmented SVE Trenches<sup>4,5</sup>**

The preliminary augmented SVE trench system adds seven segments (i.e., Segments 1 through 7) to the existing SVE trench layout, each of varying length.<sup>6</sup> The proposed locations of the augmented SVE trench segments are shown on Figure 2 and Figure 3. A short lateral for the south end of SVE trench Segment 5 has been extended into Hot Spot Area 2 and a short lateral from the western portion of Segment 6 has been extended into Hot Spot Areas 1 and 1A.

Each of the augmented SVE trenches will be approximately 18 to 24 inches wide. The trenches will be situated to intercept permeable lenses in the till unit, above the sand and gravel unit (see Figure 4). It is anticipated that the existing ECC water treatment system will be sufficient to treat till water from these trenches. Riser pipes will be installed within each SVE trench to allow for initial removal of excess water, if necessary.

The discharge pipes from the augmented SVE trench system will run aboveground to an aboveground manifold, which leads to the existing ECC water treatment system. All SVE discharge piping will be protected from freezing using either soil berms and/or heat trace lines. Appendix A contains a description of the existing treatment system.

### **2.2.3 SVE Trench Installation Methodology**

The excavated soil will be tested to determine if it exceeds either the Acceptable Soil Concentrations as listed in Table Z-1-1<sup>7</sup> or if the Synthetic

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<sup>4</sup> The configuration presented herein does not represent a detailed or final design. Rather, the placement of the trenches has been presented to assist with the conceptual description of the intended construction theory. Final location of the augmented SVE trench system, to be approved by USEPA in consultation with IDEM, will be determined during the installation based on the field conditions.

<sup>5</sup> Any modifications to the location and configuration of the augmented SVE Trench System will be subject to approval by USEPA.

<sup>6</sup> Configuration of the trench system may be modified, as approved by USEPA in consultation with IDEM, based upon any additional soil characterization activities desired by the contractors prior to installation, observations made during construction of the thin barrier curtain wall, and any unforeseen conditions identified during trench construction.

<sup>7</sup> The Acceptable Soil Concentrations reflect adjustments from Table 3-1 of the Consent Decree based on consideration of potential human exposure pathways at the Site as provided for in footnote 4 of Table Z-1-1 and Table Z-1-2.

Precipitate Leaching Procedure (SPLP) exceeds the Acceptable Stream Concentrations as listed in Table Z-1-1. If the soils exceed the Acceptable Soil Concentrations as listed in Table Z-1-1, the soils either will be treated on site to achieve the Acceptable Soil Concentrations as listed in Table Z-1-1 or disposed of off site according to applicable USEPA and IDEM regulations and ARARs. If the soils do not exceed the Acceptable Soil Concentrations as listed in Table Z-1-1 (either before or after on site treatment, if any) but the SPLP of the soils exceeds the Applicable Stream Concentrations as listed in Table Z-1-1, the soils will be analyzed for potential impact to Unnamed Ditch using the Revised Universal Soil Loss Equation (RUSLE). If the RUSLE indicates the potential for an impact, the soils will either be disposed of off site according to applicable USEPA and IDEM regulations and ARARs or placed beneath a 12-inch minimum vegetated soil cover of native, uncontaminated soils on the Northern or Central portions of the Site. If the RUSLE does not indicate the potential for an impact, the soils will be placed on the Northern or Central portions of the Site and vegetated, unless the Trustees elect to dispose of the soils off site according to applicable USEPA and IDEM regulations and ARARs. Details will be presented in the design report. The SVE trenches will be installed utilizing excavation equipment and a biopolymer such as natural or synthetic guar gum. The approximate locations and depths of the trenches are depicted on Figures 2 and 3, respectively. The excavations will be performed through the guar gum to prevent the trench walls from collapsing during the excavation and to reduce the potential of the lower sand and gravel unit from heaving at the bottom of the excavation.

The guar gum will be added to the trenches, as necessary, as the excavations proceed to maintain guar gum in the trench to within approximately two feet of the ground surface. Excavation spoils will be temporarily placed in staging areas adjacent to the trenches. As the spoils are stockpiled, the guar gum will drain from the spoils and flow back into the excavation. Berms and/or silt fencing will be added along the Unnamed Ditch to preclude potential guar gum solids or excavation spoils from entering the Ditch. Upon completion of the trench excavation activities,

all stockpiled excavation spoils will be placed within the former Southern Concrete Pad Area (SCPA).

The SVE trenches will be backfilled with pea gravel or similar granular material. The pea gravel backfill will be installed to within approximately two feet of the surface of each trench. As each trench is backfilled with pea gravel, a slotted four-inch-diameter horizontal PVC pipe (SVE pipe) will be installed in the trench (see Figure 4). The optimum placement depth of the horizontal PVC pipe, within each trench segment, will be determined during the design phase. Measures necessary to avoid the potential fouling of the SVE pipe will also be addressed during the design phase.

The horizontal slotted pipe will be fabricated with solid vertical PVC access pipes installed at three locations on each of the six excavation trenches. These vertical PVC access pipes will either be connected to the SVE system or will be capped and equipped with a vacuum gauge above the final grade of the trench. The multiple risers will be installed to allow the installation of additional equipment/instrumentation, if necessary, to monitor the effectiveness of the SVE system, and for the addition of enzymes necessary to dissolve the guar gum after completing each trench.

In addition, one four-inch-diameter PVC riser pipe will be installed within each trench while backfilling is performed. These pipes will be installed at the low point of each trench and will be used for initial development and guar gum removal (see discussion below). Each PVC riser pipe will be equipped with a five- or ten-foot section of PVC screen, as appropriate, depending on the total depth of the trench at the respective location of the riser pipe. Solid PVC casing will extend from the screen to the surface of the trench (see Figure 5).

After each trench is backfilled with pea gravel and the access pipe and PVC riser pipes are installed, an appropriate enzyme will be added by the contractor to dissolve the guar gum. The enzyme will be pumped out of the trenches using the

four-inch diameter PVC riser pipes. Guar gum displaced during the excavation or guar gum removed from the PVC riser pipes during the enzyme addition will be containerized and characterized. After assessment of the laboratory results to characterize that dissolution of the guar gum is complete, the water will, if necessary, be treated in the on-site treatment system and managed/disposed of in accordance with applicable standards and ARARs.

Additional soil will be removed at the surface of each trench to allow for the installation of a seal that will prevent vacuum leaks from the SVE trenches to the ground surface. A high-density polyethylene (HDPE) liner will be installed at the base of this excavation over the gravel backfill in each trench and will be keyed into the surrounding soil. The seal will then be backfilled with clay material and will be suitably compacted. The backfill may consist of the soils excavated to construct the seal.

After the seal is completed, a protective casing will be installed over the top of each PVC riser pipe. Excavations will be performed through the seal at each riser pipe location for the installation of the protective casing. A geotextile will be placed around the PVC riser for each well, across the pea gravel backfill in each excavation. Bentonite or grout will be placed over the geotextile and the base of the remaining portion of the excavation to seal the casing and to prevent leaks to the surface from the SVE trench. The protective casing will then be installed and the annular space around the casing will be backfilled and compacted as appropriate to maintain the integrity of the seal. Either hydraulic cement or silicon caulk will be used within the protective casing to seal the riser pipe from the well and the casing. An appropriate well cap will be installed to prevent vacuum leaks through the protective casing. A vacuum gauge will either be installed through the well cap or through the riser pipe in the casing. The surface of the protective casing will be installed approximately three inches above the surrounding grade to prevent water from ponding on the surface.



#### **2.2.4 Thin Barrier Curtain Wall**

The results of testing performed during November 1998 indicate that sand lenses within the till unit near Unnamed Ditch may be hydraulically connected to Unnamed Ditch. In response, the modified Additional Work will include the construction of a thin barrier curtain wall along the east, south, and southwest sides of the ECC Site, adjacent to the augmented SVE trench system (see Figure 2). This will eliminate, *inter alias*, any connection between sand lenses in the till unit and Unnamed Ditch, thus significantly decreasing the volume of water being removed and treated and cutting off a potential source of contamination to the Ditch. Appendix B contains the methodology to be used to construct the thin barrier curtain wall, as well as the associated piezometers that will be used to monitor the effectiveness of the thin barrier curtain wall.

#### **2.3 Well Installation**

Construction related activities at the ECC Site during 1998 and 1999 may have damaged monitoring well S-4A. As a result, a new well (S-4B) will be installed approximately 50 feet to the south (downgradient) of S-4A, in a low traffic area to be agreed on by the parties. The S-4A well will be abandoned following the installation of the S-4B well. The proposed location for S-4B is shown on Figure 6.

Following the construction of the augmented SVE trench system, a new sand and gravel unit well (i.e., S-5) will be installed south of the southeast portion of the thin barrier curtain wall. The proposed location for S-5 is also shown on Figure 6. Installation and construction details for wells S-4B and S-5 will be presented in the design report.

#### **2.4 Permeable Reactive Gate System**

A PRGS will be installed during the SVE trench construction and will be activated once the Soil Vapor Standards have been achieved in the augmented SVE trench system. The PRGS is intended to act as a backup system, which will prevent the build-up of till

water on the upgradient side of the thin barrier curtain wall and will treat till water that is allowed to leave this area.<sup>8</sup>

The PRGS will utilize zero-valent granular iron to degrade chlorinated compounds to inorganic chloride and dehalogenated organic compounds. This system is appropriate for the ECC Site compounds of concern (COCs) since this treatment technology has been demonstrated during numerous bench scale studies, pilot studies, and full-scale remediation projects for various chlorinated compounds in ground water and wastewater. The reaction mechanism for the degradation of chlorinated compounds with zero-valent iron has been the mostly widely studied to date. Based upon recent research, the predominant degradation pathways are expected to consist of: (1) oxidation of the iron due to the presence of dissolved oxygen (DO) in ground water entering the treatment system creating hydroxyl radicals that degrade the chlorinated compounds; and (2) further degradation of chlorinated compounds during reducing reactions with iron, a strong reducing agent, through electron transfer. The chlorinated compounds are degraded to inorganic chloride, ethene and ethane, partially dechlorinated byproducts (e.g., 1,2-dichloroethene; 1,1-dichloroethene; and vinyl chloride) and small-chained hydrocarbons (e.g., methane and propane). Treatment of these partially dechlorinated byproducts is achieved by the same reducing reactions with iron by providing sufficient retention time in the treatment system.

The PRGS will utilize the augmented SVE trench system to collect and convey till water by gravity to treatment gates containing iron filings. The discharge from the treatment gates will flow by gravity through pipe penetrations in the thin barrier curtain wall to a subsurface infiltration trench located outside and parallel to the curtain wall. During operation, the PRGS will be inspected on a quarterly or semi-annual basis in conformance with the water-sampling schedule. If inspection of the PRGS indicates bypass, blockage or other conditions that could restrict or inhibit its performance, the PRGS will be repaired/reconditioned in accordance with a plan approved by USEPA in

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<sup>8</sup> Due to the presence of the cap on the northern portion of the Site and the presence of the low-permeability soils used for backfill in the southern portion of the Site, very little till water is expected to build-up along the upgradient side of the adjacent thin barrier curtain wall.

consultation with IDEM. Further details regarding the PRGS will be presented within the design report.

## **3.0 ACTIVE PHASE**

### **3.1 Augmented SVE Trench System Vapor Removal**

The augmented SVE trench system will be designed to achieve the Soil Vapor Standards described in Section 3.2 below. The time required to attain the Soil Vapor Standards is dependent upon the adequate removal of water, the initial concentrations of the COCs, the minimization of short-circuiting, operating air flow rate and temperature, and the efficient diffusion of air through the soil pores. Based upon the previous SVE activities conducted at the Site, the attainment of shutdown standards is expected to occur within 3 to 6 months of operation of the dual-phase extraction systems in the augmented SVE trench system. However, the actual time may be longer or shorter.

#### **3.1.1 Sample Collection Frequency and Methodology**

The augmented SVE trench system will be installed to permit vapor samples to be collected from each individual SVE trench and from the combined vapor stream from all operating SVE trenches. Vapor samples will be collected in accordance with the sample methodology previously agreed to by the USEPA and IDEM, as presented in Section 6 of the Revised Remedial Action Field Sampling Plan (FSP); Revision 4 dated April 28, 1997, as well as the modifications to the sampling plan as presented in the October 31, 2000 letter to USEPA and IDEM. These documents are attached as Appendix C. The vapor from each individual SVE trench will be sampled daily during the first week of operation, weekly for the following 4 weeks, and biweekly thereafter. The collected vapor samples will be analyzed for total organics using an existing in-line Series 8800 Continuous Analyzer and/or an off-site laboratory<sup>9</sup> and for the VOCs and SVOC presented in Section 3.2 below using National Institute of Occupational Safety and Health (NIOSH) Methods 1500 and 1003 (modified), and Occupational Safety and health Administration (OSHA) Method 32, respectively. Also, the vapor flow rate will be monitored and recorded to provide sufficient data to calculate the mass of organics

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<sup>9</sup> The usefulness of the existing vapor analyzer will be assessed during the design phase. If used, an initial correlation will be developed between the in-line analyzer results and samples sent off site for analysis. A detailed schedule and methodology for the vapor sampling will be presented in the design report.

removed from the soils and the effectiveness of the system. The collected vapor sample data will be used by the Trustees or their contractor to determine how best to utilize and apportion the SVE energy among the SVE trenches. USEPA and IDEM will receive advance notice of the temporary suspension of operation of any trench or trenches. Final shutdown of any trench or trenches must be approved by USEPA in consultation with IDEM.

### **3.1.2 Augmented SVE Trench System Shutdown Methodology**

When the vapor concentrations in all SVE trenches are less than the Soil Vapor Standards, the restart spike method on the combined vapor flow will be used to demonstrate that the vapor standards have been achieved.

The restart spike procedure will include shutting down the entire trench vapor extraction system for a period of 3 days. Prior to such shutdown, authorization will be obtained from USEPA in consultation with IDEM. On restarting the vapor extraction system, all SVE trenches will be operated as during normal operations. A sample of the combined soil vapor will be collected over the time period (starting 30 minutes after restarting the SVE system) that is needed to exchange the air in one pore volume of soil to provide a representative sample of the soil vapor concentrations in equilibrium with the soil concentrations. If the combined sample exceeds the vapor standards, the system will be reactivated for a period of one week, and the shutdown process described above will again be implemented.

When results of analyses of the combined soil vapor sample collected from two consecutive restart spikes conducted two weeks apart show that concentrations of each COC meet the Soil Vapor Standards described in Section 3.2, a water sample will be collected from the augmented SVE trench system. If the water sample meets the Acceptable Stream Concentrations presented in Table Z-1-1, then operation of the SVE system will be terminated subject to any restart required under Section 4.0, Item 1. If the water sample does not meet the Acceptable Stream

Concentrations , then operation of the SVE system will continue for an additional 90 days before resampling the trench water.

### **3.2 Soil Vapor Standards**

The Soil Vapor Standards shown in Table Z-1-3 will be used, as described in the previous section, to determine shutdown of the augmented of SVE system. Reductions to the Table Z-1-3 list may be proposed to USEPA and IDEM following the completion of the weekly vapor sampling events.

### **3.3 Surface Water Monitoring**

During operation of the augmented SVE trench system, the surface water within the Unnamed Ditch will be monitored on a semiannual basis. The surface water samples will be collected upstream and downstream of the ECC Site and at the Northside Landfill discharge location within Unnamed Ditch, as depicted on Figure 6. Additional samples may be collected at the discretion of the ECC Site Trustees.

Surface water samples will be collected as described in Section 6 of the Revised Remedial Action FSP; Revision 4 dated April 28, 1997, attached hereto as Appendix C. The surface water samples will be analyzed for compounds with Acceptable Stream Concentrations (Table Z-1-1) using USEPA Methods 8260B and 8270C.<sup>10</sup> If surface water is not encountered, the specific sampling event will be considered complete despite the inability to gather a full set of data.

### **3.4 Subsurface Water Monitoring**

During operation of the augmented SVE trench system, the subsurface water within the augmented trench system and wells S-1, S-4B, and S-5 will be monitored on a semiannual basis. Wells S-1, S-4B, and S-5 are depicted on Figure 6. Additional samples may be collected at the discretion of the ECC Site Trustees.

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<sup>10</sup> The Acceptable Stream Concentrations reflect adjustments for background conditions as provided for in footnote 2 to Table Z-1-1.

Subsurface water samples will be collected from the wells as described in Section 6 of the Revised Remedial Action FSP, Revision 4, dated April 28, 1997, with modifications outlined in the Low Flow Ground Water Sampling proposal dated November 10, 2000, attached hereto as Appendix C. The sampling procedure for the combined trench water sample will be presented within the design report.

The subsurface water samples will be analyzed for compounds with Acceptable Stream Concentrations (Table Z-1-1) using USEPA Methods 8260B and 8270C.<sup>11</sup> If subsurface water is not encountered in a trench, the specific sampling event, for that trench, will be considered complete despite the inability to gather a full set of data.

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<sup>11</sup> The Acceptable Subsurface Water Concentrations reflect adjustments for background conditions as provided for in footnote 1 to Table Z-1-1.

## 4.0 PHASE I LONG TERM MONITORING

The Phase I Long Term Monitoring period has been defined as the five-year period beginning when the Soil Vapor Standards have been achieved in the augmented SVE trenches. Once the Soil Vapor Standards have been achieved, quarterly sampling and analysis of surface and subsurface water will continue for an additional 2 years and semi-annually thereafter for 3 years.

The water level within the augmented SVE trench system will be maintained by gravity drainage using the PRGS. Control of the water level within the trench system will control the hydraulic gradient within the till unit across the Site, to prevent the flow of till water around or below the augmented SVE system.

The PRGS will utilize the augmented SVE trench system to collect and convey till water by gravity to treatment gates containing zero-valent granular iron filings. The PRGS location, design and installation methodology will be presented within the design report.

Five performance criteria for the Phase I Long Term Monitoring have been determined. The actions to be taken in response to each of the performance criteria are different. The performance criteria and their respective proposed response actions are as follows:

1. If the quarterly/semi-annual subsurface water samples collected from the augmented SVE trench system contain VOCs at concentrations greater than Acceptable Stream Concentrations (Table Z-1-1), then the augmented SVE system will be reactivated<sup>12</sup> until the vapor meets the Soil Vapor Standards in Table Z-1-3. If the SVE system is restarted, the Phase I Long Term Monitoring five-year period will also restart unless otherwise agreed to by USEPA and IDEM.

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<sup>12</sup> The control of back-venting and backflow from the PRGS into the trench system will be accomplished by valving.



2. If the quarterly/semi-annual monitoring events, using the water levels collected from the four thin barrier curtain wall piezometers show that till water is flowing around the augmented SVE system, then the necessary adjustments will be made to the PRGS as approved by USEPA in consultation with IDEM.
3. If the quarterly/semi-annual surface water samples collected immediately downgradient from the Site, from Unnamed Ditch, contain VOCs at concentrations greater than the Acceptable Stream Concentrations (Table Z-1-1), then the source of these compounds will be investigated and further remediation will be evaluated and, if determined to be necessary by the Trustees or by USEPA in consultation with IDEM, a proposal will be submitted for approval by USEPA in consultation with IDEM.
4. The quarterly/semi-annual water level measurements to be collected from the thin barrier curtain wall piezometers will be used to confirm the integrity of the thin barrier curtain wall. If the thin barrier curtain wall is found to be leaking, then the wall will be repaired under a plan approved by USEPA in consultation with IDEM.
5. If quarterly/semi-annual sampling of sand and gravel monitoring wells S-1, S-4B, or S-5 show increasing trends in VOC concentrations that are above Acceptable Stream Concentrations (Table Z-1-1), then the cause of the trends will be evaluated and a report submitted for approval by USEPA, in consultation with IDEM, that evaluates the trends and proposes additional remedial actions (if necessary).

At the completion of the Phase I Long Term Monitoring period, Phase II Long Term Monitoring will begin at the Site.

## **5.0 PHASE II LONG TERM MONITORING**

The Phase II Long Term Monitoring will follow the completion of Phase I Long Term Monitoring. The PRGS will allow a treated outlet for any subsurface water that accumulates within the till on the Site, thus preventing the flow of till water around the thin barrier curtain wall. During Phase II Long Term Monitoring, maintenance of the PRGS system and monitoring of the PRGS effluent will be conducted on an annual basis. If inspection of the PRGS indicates bypass, blockage or other conditions that could restrict or inhibit its performance, the PRGS will be repaired/reconditioned in accordance with a plan approved by USEPA in consultation with IDEM. If the PRGS effluent exceeds the acceptable stream concentrations in Table Z-1-1, the PRGS "bed" will be replaced. If the fresh PRGS bed cannot meet the required standards, additional measures to meet the standards will be evaluated. Phase II Long Term Monitoring will continue on a semi-annual schedule until USEPA agrees, in consultation with IDEM, that annual sampling may resume. During the Phase II Long Term Monitoring, the Site final cover and any applicable access restrictions will be maintained.

The determination of whether the Site poses an unacceptable risk to human health and the environment, and therefore if continued Phase II Long Term Monitoring is warranted or additional measures may be necessary, should be determined as part of the five-year reviews provided for under 42 USC 9621(c) based on the PRGS monitoring data. Additional measures shall be taken if, based on the five year review or other new information, USEPA determines (in consultation with IDEM) that the modified Additional Work described in this Attachment Z-1 is not successfully protecting Unnamed Ditch from the discharge of contamination above the Acceptable Stream Standards in Table Z-1-1.

During Long Term Monitoring, the Site will be evaluated for certification by the Ready for Reuse program (or equivalent), or the IDEM RISC program if applicable, for surface use that is non-intrusive to the subsurface at the Site and consistent with any use

restrictions and/or institutional controls placed on the property, and includes maintenance of the PRGS.

## 6.0 SCHEDULE

A schedule for the modified Additional Work is presented on Table Z-1-4.

## TABLES

TABLE Z-1-1  
SITE-SPECIFIC ACCEPTABLE CONCENTRATIONS  
ECC SUPERFUND SITE  
ZIONSVILLE, INDIANA  
(Page 1 of 2)

Parameter	Acceptable Subsurface Water Concentration <sup>1</sup> (ug/L)	Acceptable Stream Concentration <sup>2,3</sup> (ug/L)	Acceptable Soil Concentration <sup>4,5</sup> (ug/kg)
<b>Volatile Organic Compounds</b>			
Acetone	3,500 RB		370,000
1,1-Dichloroethene	7 MCL		42,000
1,2-Dichloroethene (total)	70 MCL	7.4 SB	5,800
Ethylbenzene	680 MCL	3,280	160,000
Methylene chloride	133 SSB	15.7	1,800
Methyl ethyl ketone	170 LDWHA		250,000
Methyl isobutyl ketone	1,750 RB		75,000
Tetrachloroethene	0.69 RB	8.85	640
Toluene	2,000 MCL	3,400	240,000
1,1,1-Trichloroethane	200 MCL	5,280	280,000
1,1,2-Trichloroethane	0.61 RB	41.8	300
Trichloroethene	5 MCL	80.7	82
Vinyl chloride	2 MCL	525	13
Xylenes (total)	10,000 MCL		170,000
<b>Semi-Volatile Organic Compounds</b>			
Bis (2-ethylhexyl) phthalate	7.3 SSB	50,000	
Di-n-butyl phthalate	3,500 RB	154,000	
1,2-Dichlorobenzene	600 MCL	763	220,000
Diethyl phthalate	28,000 RB	52,100	
Isophorone	8.5 RB		
Naphthalene	14,000 RB	620	
Phenol	1,400 RB	570	160,000
<b>Inorganics</b>			
Antimony	15.6 SSB		
Arsenic	50 MCL	9.2 SB	
Barium	1,000 MCL		
Beryllium	4 MCL		
Cadmium	10 MCL		
Chromium VI	50 MCL	77.6 SB	
Lead	50 MCL	19.8 SB	
Manganese	7,000 RB		
Nickel	150 LDWHA	100	
Silver	50 MCL		
Tin	21,000 RB		
Vanadium	245 RB		
Zinc	7,000 RB	123 SB	
Cyanide (total)	7,000 RB	17.2 SB	
<b>Polychlorinated biphenyls</b>			
Aroclor 1016	0.6 SSB	0.5 SB	
Aroclor 1221	1.1 SSB	0.9 SB	
Aroclor 1232	0.6 SSB	0.5 SB	
Aroclor 1242	0.6 SSB	0.5 SB	
Aroclor 1248	0.6 SSB	0.5 SB	
Aroclor 1254	0.6 SSB	0.5 SB	
Aroclor 1260	0.6 SSB	0.5 SB	

**TABLE Z-1-1**  
**SITE-SPECIFIC ACCEPTABLE CONCENTRATIONS**  
**ECC SUPERFUND SITE**  
**ZIONSVILLE, INDIANA**  
**(Page 2 of 2)**

**Notes:**

<sup>1</sup> RB = Risk Based standard. USEPA, Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals), December 1991.

MCL = Drinking Water Maximum Contaminant Level (40 CFR 141).

SSB = Applicable Subsurface Water Background Concentrations as defined as two standard deviations above the calculated mean of 12 sample sets of background subsurface water samples. Background subsurface water samples were collected from wells T-5 and S-1 (see Appendix E, Tables E-1 and E-3 for calculations).

LDWHA = Lifetime Drinking Water Health Advisory. U.S. EPA, Superfund Public Health Evaluation Manual update of November 16, 1987.

<sup>2</sup> SB = Applicable Surface Water Background Concentrations were defined as two standard deviations above the calculated mean of 12 sample sets of background surface water samples. Background surface water samples were collected from the surface water sample location SW-1 (see Appendix E, Tables E-2 and E-4 for calculations).

For the purposes of Revised Attachment Z-1, if the methodology for surface water monitoring described in Sections 3.3 and 4.0 indicates background levels are elevated above the levels in Appendix E, the background levels and the corresponding values in Table Z-1-1 will be recalculated to adjust for such increased background.

<sup>3</sup> Stream Criteria, from Table 1 of the Record of Decision for the site, September 25, 1987 (or calculated on the same basis) unless otherwise noted.

<sup>4</sup> Acceptable Soil Concentrations are the minimum IDEM RISC non-default closure levels for commercial/industrial soil direct contact, commercial/industrial soil migration to groundwater, construction soils, and the soil saturation limit (see Table Z-1-2 for calculations).

<sup>5</sup> The Acceptable Soil Concentrations, within the meaning of this Exhibit A and the Consent Decree, will be achieved when the arithmetic average of the soil sample results for each parameter, assigning all nondetect results a value of 1/2 the detection limit, do not exceed the values set forth in this table by more than 25%.

TABLE Z-1-2  
SITE-SPECIFIC SOIL EXPOSURE CALCULATIONS<sup>1</sup>  
ENVIROCHEM SUPERFUND SITE  
ZIONSVILLE, INDIANA

Parameter	Soil Saturation Limit $C_{sat}$ (mg/kg)	Commercial/Industrial Soil Direct Contact		Commercial/Industrial Soil Migration to Groundwater		Construction Soils	
		Carcinogen $C_{ssic}$ (mg/kg)	Non-carcinogen $C_{ssin}$ (mg/kg)	Carcinogen $C_{sbsic}$ (mg/kg)	Non-carcinogen $C_{sbsin}$ (mg/kg)	Carcinogen $C_{sscc}$ (mg/kg)	Non-carcinogen $C_{sscn}$ (mg/kg)
Acetone	201,292	NE	13,987	NE	370	NE	72,936
1,1-Dichloroethene	930	NE	738	NE	42	NE	3,861
cis-1,2-Dichloroethene	1,001	NE	246	NE	5.8	NE	1,240
trans-1,2-Dichloroethene	2,138	NE	392	NE	14	NE	2,012
Ethylbenzene	160	NE	9,129	NE	195	NE	36,644
Methylene chloride	3,008	355	12,472	1.8	28	35,203	36,962
Methyl ethyl ketone	28,194	NE	119,270	NE	250	NE	360,827
Methyl isobutyl ketone	8,750	NE	31,537	NE	75	NE	65,900
Tetrachloroethene	115	40	214	0.64	12	4,258	1,093
Toluene	309	NE	3,174	NE	240	NE	16,531
1,1,1-Trichloroethane	642	NE	10,663	NE	280	NE	51,059
1,1,2-Trichloroethane	1,342	24	194	0.30	2.5	2,786	896
Trichloroethene	627	1.7	93	0.082	0.35	211	224
Vinyl chloride	928	4.8	262	0.013	2.1	319	1,064
Xylenes (total)	170	NE	1,242	NE	426	NE	6,724
1,2-Dichlorobenzene	220	NE	5,103	NE	265	NE	22,889
Phenol	21,329	NE	113,262	NE	160	NE	243,091

**Legend:**

$C_{sat}$	Soil Saturation Limit (Appendix D, Table C, Equation 7-3)
$C_{ssic}$	Commercial/Industrial Soil Closure Level for Direct Contact for Carcinogens (Appendix D, Table C, Equation A1-9)
$C_{ssin}$	Commercial/Industrial Soil Closure Level for Direct Contact for Non-Carcinogens (Appendix D, Table C, Equation A1-10)
$C_{sbsic}$	Commercial/Industrial Migration to Ground Water Contact Closure Level for Carcinogens (Appendix D, Table C, Equation A1-11)
$C_{sbsin}$	Commercial/Industrial Migration to Ground Water Contact Closure Level for Non-Carcinogens (Appendix D, Table C, Equation A1-12)
$C_{sscc}$	Construction Soil Closure Level for Carcinogens (Appendix D, Table C, Equation A1-13)
$C_{sscn}$	Construction Soil Closure Level for Non-Carcinogens (Appendix D, Table C, Equation A1-14)
NE	Not established

**Notes:**

<sup>1</sup> Default IDEM RJSC equation parameters/exposure assumptions were used for the closure level calculations as included in Appendix D, Table D. All default exposure equations and human health toxicity default values were used for the calculations as included in Appendix D, Tables C and F.



**TABLE Z-1-3**  
**SOIL VAPOR STANDARDS**  
**ECC SUPERFUND SITE**  
**ZIONSVILLE, INDIANA**

Compound	Soil Vapor Standard	
	(mg/L)	(ppmv)
<b>Volatile Organics (VOCs):</b>		
Acetone		244
1,1-Dichloroethene	2	481
1,2-Dichloroethene (total)	3.7	880
Ethylbenzene	37	8,076
Methylene chloride	0.08	22
Methyl ethyl ketone	0.04	13
Methyl isobutyl ketone	0.69	159
Tetrachloroethene	0.11	16
Toluene	107	27,090
1,1,1-Trichloroethane	8.3	1,442
1,1,2-Trichloroethane	0.01	1
Trichloroethene	0.39	68
Vinyl chloride	919.2	338,808
Total Xylenes	595	130,244
<b>Base Neutral/Acid OrGanics:</b>		
1,2-Dichlorobenzene	9.3	1,466
Phenol	0.005	1.3

**TABLE Z-1-4**  
**PRELIMINARY SCHEDULE**  
**ECC SUPERFUND SITE**  
**ZIONSVILLE, INDIANA**

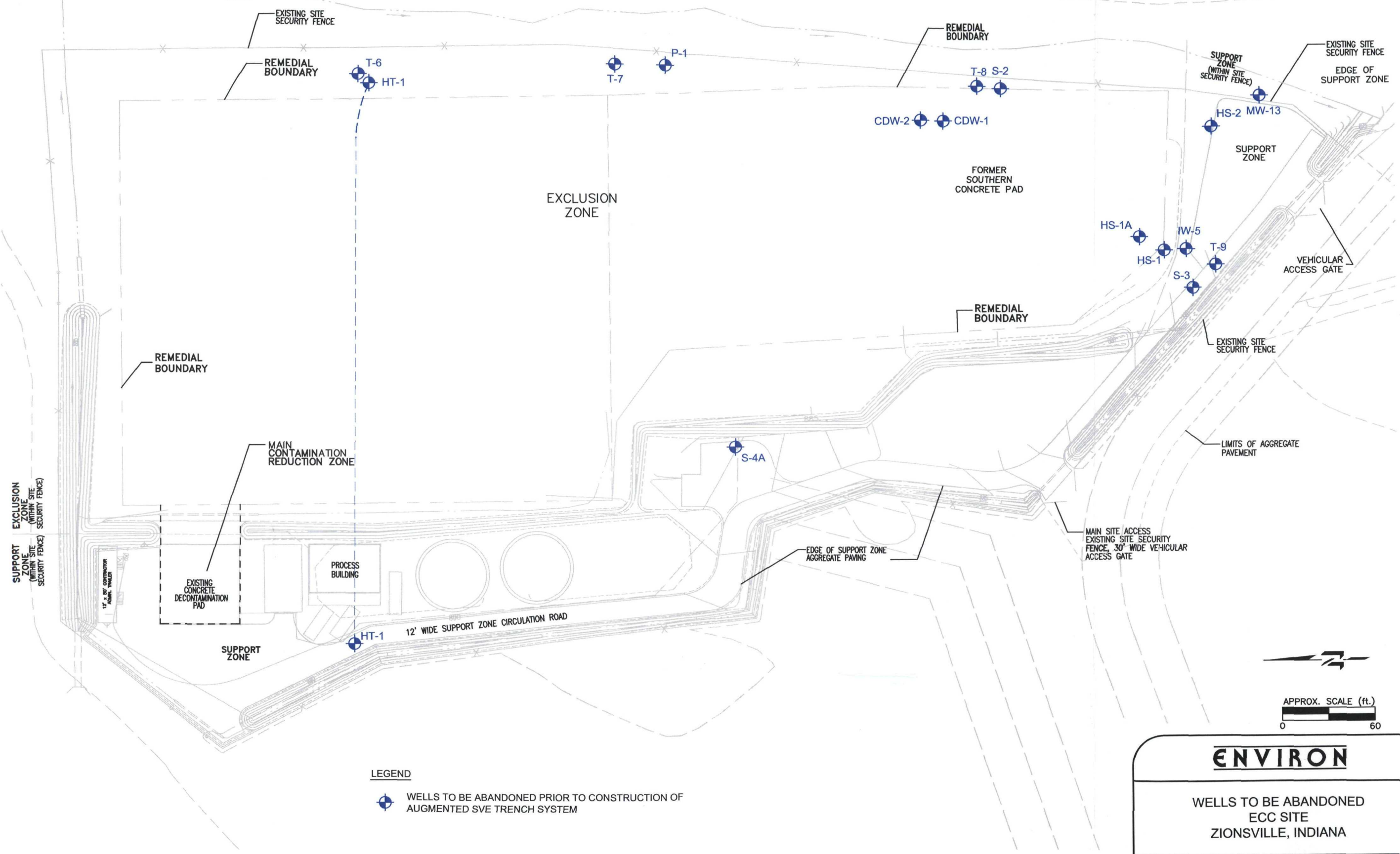
<b>1</b>	<b>100% Design Report</b> (a) Draft 100% Design Report to Agency (b) Incorporation of Agency Comments	Monday, October 17, 2005 45 Days from receipt of Agency comments.
<b>2</b>	<b>Revised Attachment Z-1 Construction</b> <sup>1</sup> (a) Augmented SVE Trench System (b) Permeable Reactive Gates System	16 Months from approval of the 100% Design and approval of the amendment to the Consent Decree approving Attachment Z-1, whichever is later.
<b>3</b>	<b>Construction Completion Report</b> (a) Draft Completion Report to Agency (b) Incorporation of Agency Comments	30 Days from completion of construction. 15 Days from receipt of Agency comments.
<b>4</b>	<b>Phase I Long Term Monitoring</b>	5 Years from Achievement of Soil Vapor Standards in the Augmented SVE Trench System (with the period subject to restart as described in Section 4.0).
<b>5</b>	<b>Phase II Long Term Monitoring</b>	5 Years from completion of Phase I Long Term Monitoring, subject to the results of the 5-year review process as provided in Section 5.0.

**Notes:**

<sup>1</sup> Detailed construction schedule to be included in 100% Design Report.

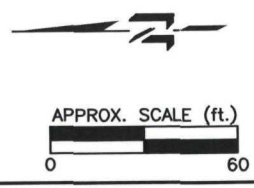
## FIGURES

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**LEGEND**

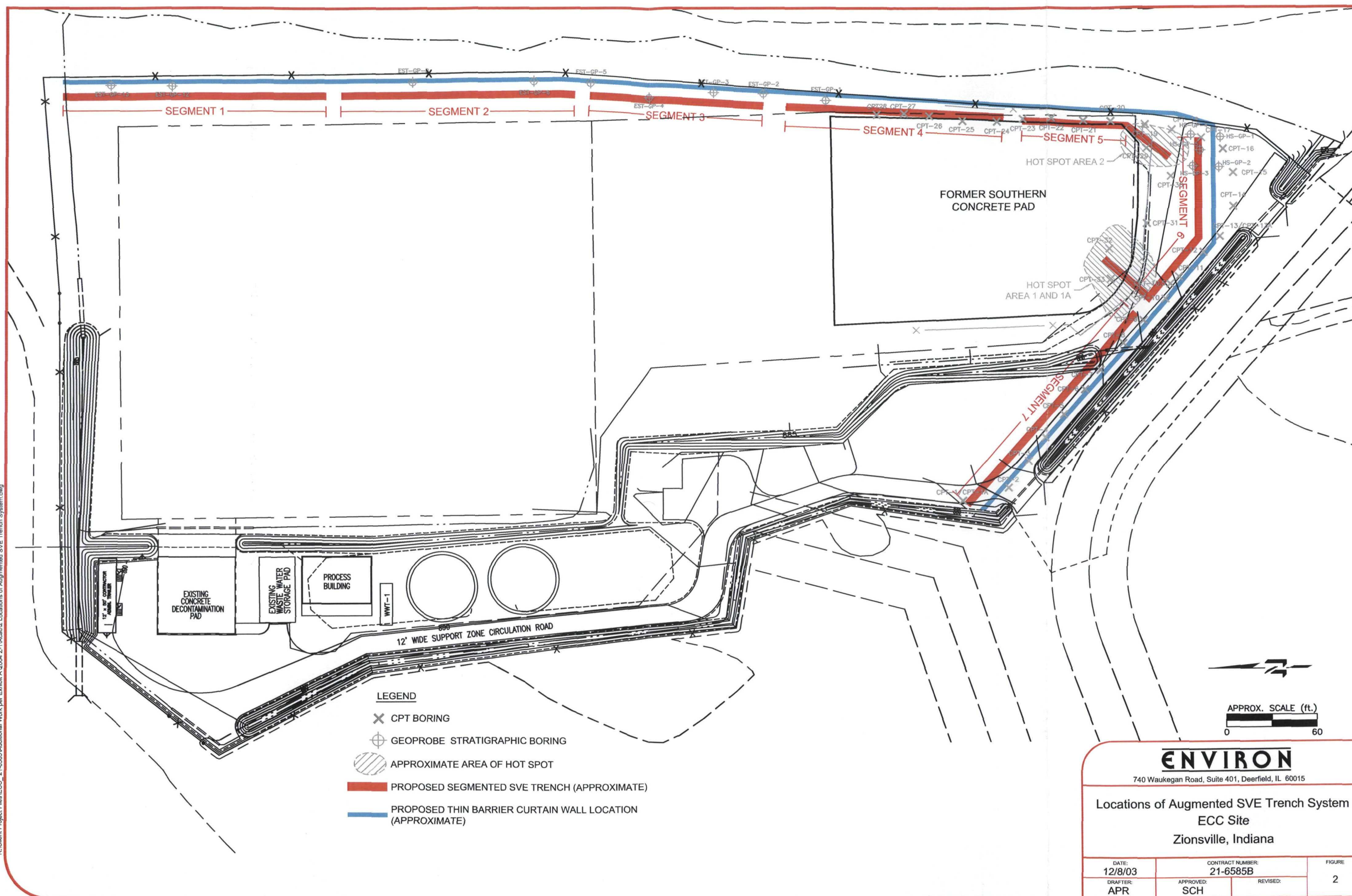
WELLS TO BE ABANDONED PRIOR TO CONSTRUCTION OF AUGMENTED SVE TRENCH SYSTEM



<b>ENVIRON</b>			
WELLS TO BE ABANDONED ECC SITE ZIONSVILLE, INDIANA			
DATE: 7/6/04	CONTRACT NUMBER: 21-6585B		FIGURE 1
DRAFTER: APR	APPROVED:	REVISED:	

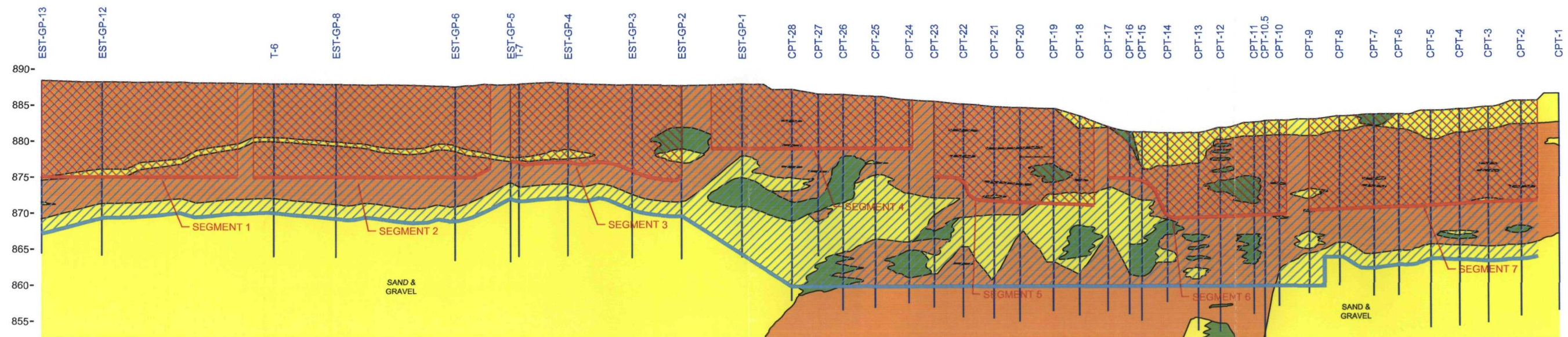


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# LEGEND

- PROPOSED BOTTOM DEPTH OF SEGMENTED SVE TRENCH  
(3 FT ABOVE TOP OF LOWER SAND & GRAVEL STRATUM (EXCEPT WHERE SHOWN AT ELEV. 868)).
- PROPOSED THIN BARRIER CURTAIN WALL LOCATION  
(2 FT INTO TOP OF LOWER SAND & GRAVEL STRATUM (EXCEPT WHERE SHOWN AT ELEVATION 860)).

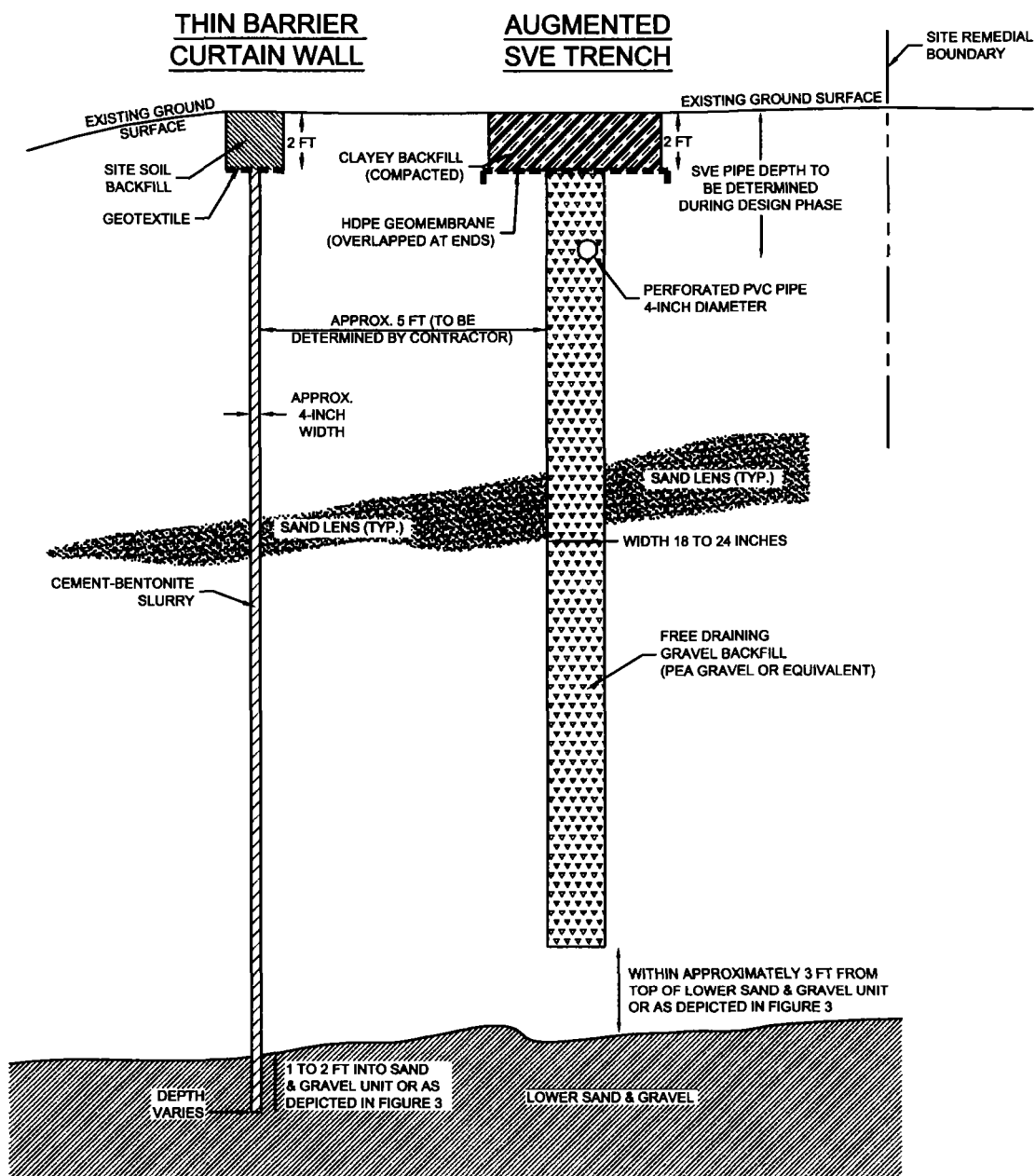
**Note:**  
Soil profile shown is a simplified presentation of field data from the boring locations shown on Figure 2.

**ENVIRON**

740 Waukegan Road, Suite 401, Deerfield, IL 60015

Augmented SVE Trench System Profile View  
ECC Site  
Zionsville, Indiana

DATE: 12/8/03	CONTRACT NUMBER: 21-6585B	FIGURE: 3
DRAFTER: APR	APPROVED: SCH	REVISED:



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**ENVIRON**

740 Waukegan Road, Suite 401, Deerfield, IL 60015

Augmented SVE Trench Typical Section  
ECC Site  
Zionsville, Indiana

Figure

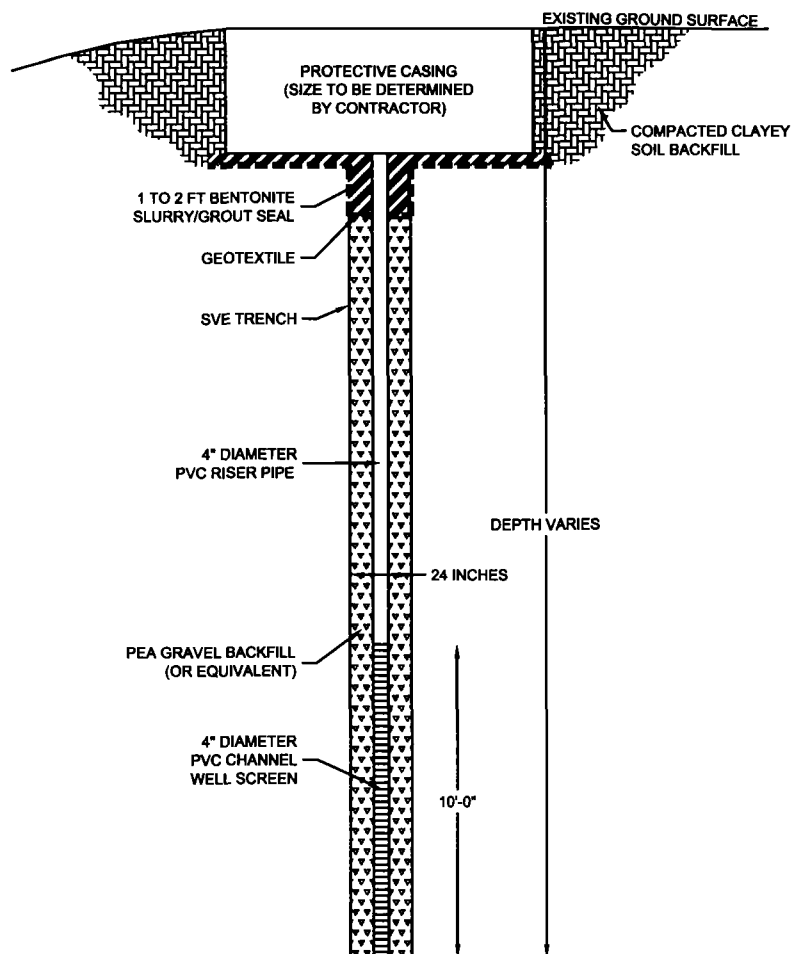
4

Drafter: APR

Date: 12/16/03

Contract Number: 21-6585B

Approved: SCH Revised:



### TYPICAL SVE TRENCH WITH PVC RISER PIPE

SCALE: 1" = 6'

#### NOTES:

1. PVC RISER PIPE LOCATIONS TO BE DETERMINED DURING DESIGN PHASE
2. INSTALLATION DURING TRENCH CONSTRUCTION
3. WELL SCREENS AVAILABLE FROM USF JOHNSON SCREENS, ST. PAUL, MN

**ENVIRON**

740 Waukegan Road, Suite 401, Deerfield, IL 60015

Typical PVC Riser Pipe  
Augmented SVE Trench  
ECC Site  
Zionsville, Indiana

Figure

5

Drafter: APR

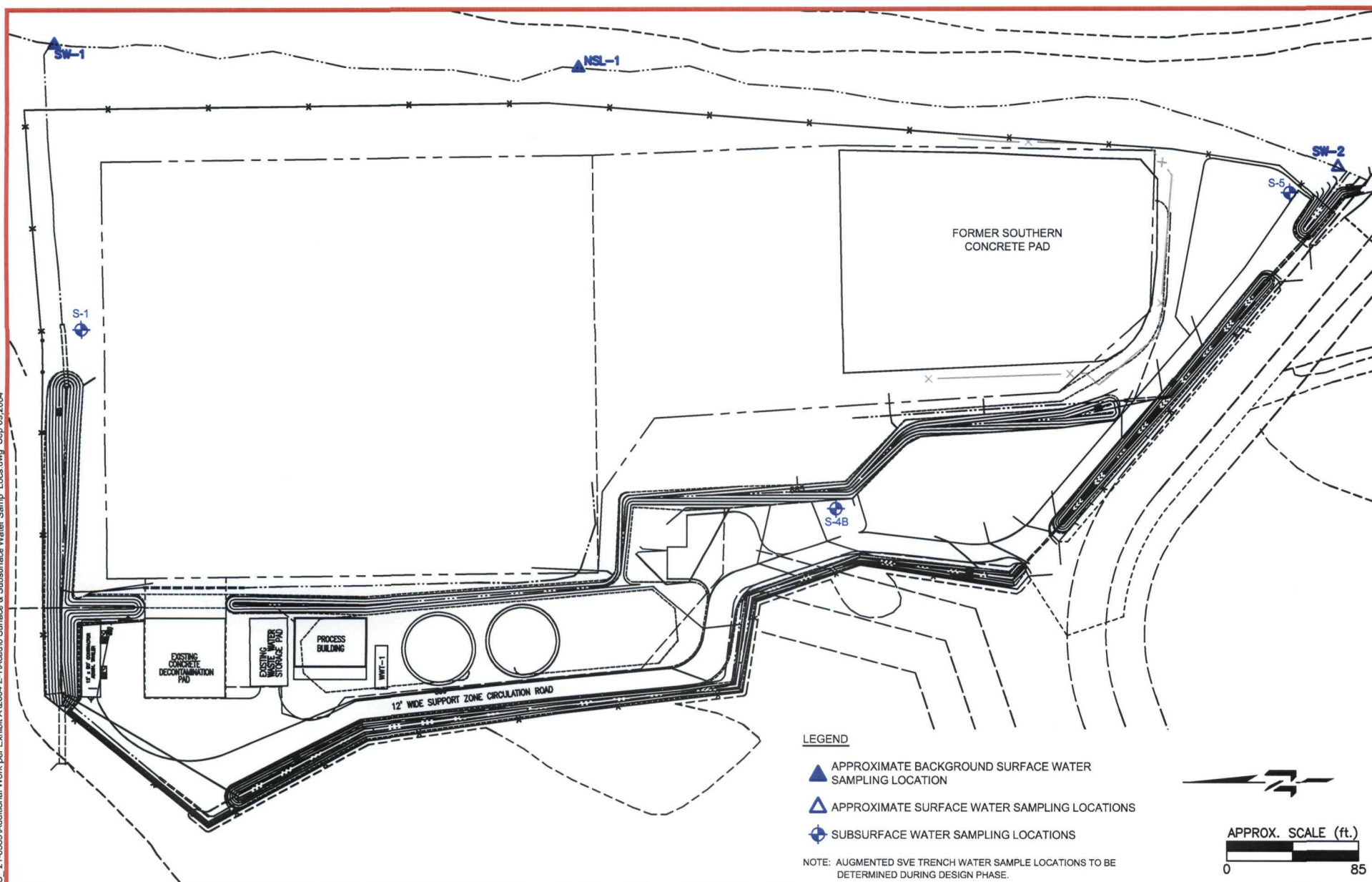
Date: 8/26/03

Contract Number: 21-6585B

Approved: SCH Revised:



R:\Client Project Files\ECC\_21-6585\Additional Work per Exhibit A\2004 2-1\Acad\6 Surface & Subsurface Water Samp Locs.dwg Sep 09 2004



**ENVIRON**

740 Waukegan Road, Suite 401, Deerfield, IL 60015

Surface and Subsurface Water Sampling Locations  
ECC Site  
Zionsville, Indiana

Figure

6

Drafter: APR

Date: 8/26/03

Contract Number: 21-6585B

Approved: SCH

Revised:

## **A P P E N D I X   A**

### **Soil Vapor and Water Treatment System**

## SOIL VAPOR AND WATER TREATMENT SYSTEM

The objective of the SVE activity is to remove VOCs and selected SVOCs (as provided herein) from the shallow till along the east, south, and southwest sides of the Site. The SVE system consists of two 60-horse power vacuum pumps with a design vacuum of 10 inches of mercury and a design backpressure of 1.25 inches of mercury. The design airflow is 1,175 cubic feet per minute (cfm) and the design discharge temperature is less than 175° Fahrenheit (F). Prior to treatment, the vapor is cooled to increase effectiveness of the carbon units. The heat exchanger has a normal airflow of 2,400 cfm and a normal water flow of 0.75 to 7 gallons per minute (gpm).

The potential effectiveness of SVE for organics removal from the ECC soils was demonstrated during a pilot test conducted by Terra Vac in June 1988. The description of the pilot test, including the results obtained, was previously submitted to the USEPA and IDEM. The test showed an initial high organics extraction rate of 1.9 pounds per day per foot of SVE trench that decreased over the course of the pilot test to a steady state rate of approximately 0.25 pounds per day per foot of SVE trench.

The full-scale effectiveness of SVE has been demonstrated by the nine-foot-deep horizontal SVE trenches and by the vertical SVE well T-2. With respect to the nine-foot-deep horizontal SVE trenches, all trenches achieved compliance with the vapor standards within 25 months as verified by restart spikes over a 2-month period. With respect to T-2, the former testing well found to contain dense non-aqueous phase liquid (DNAPL), the extracted vapors met the applicable vapor standards within a two-month period. The only source of contaminants to be extracted is associated with till water and the subsequent equilibrium with the soils in contact with the granular lenses. Therefore, the time required to attain the Soil Vapor Standards for the augmented SVE system is anticipated to be three to six months.

The SVE process at the ECC Site is intended to operate continuously. However, automatic shutdown of the system will occur in the event of an operating problem or malfunction. As noted above, the air extracted from the system will be continuously monitored by in-line instrumentation. The system will allow for the collection of samples from the individual SVE trenches or the combined air stream. Sample taps will also be provided to collect vapor samples for detailed chemical analysis. The existing on-line

instrumentation includes a photo-ionization detector (PID) and moisture analyzer. The following are conditions that will prompt a shutdown of the normal operating sequence of the SVE system:

- High vapor temperatures above the estimated acceptable range of 150°F to 180°F prior to activated carbon treatment;
- Low vapor temperatures below the estimated acceptable range of 75°F to 85°F prior to activated carbon treatment indicating relative humidity above the estimated acceptable range;
- A high water level in the water entrainment separator indicating operating problems with the liquid transfer operation;
- A high water level in a water storage tank;
- High or low pressure conditions on vacuum or injection pumps under normal operating conditions; and
- Power interruptions at the Site.

During normal operation, vapor extraction may be temporarily halted to facilitate carbon vessel change out and during transfer of water from the entrainment separator to the on-site water storage tank, or to conduct restart spike tests.

The vacuum vapor extraction system will be capable of removing water that accumulates in the SVE trenches. Also, any free liquid in the extracted vapor will be separated by gravity in an entrainment separator. A level control system will be utilized to control the removal of water that accumulates in the entrainment separator as required. The existing separator tank is equipped with a vacuum breaker system which will open the tank to the atmosphere to permit water to be transferred by pump from the separator to an on-site water storage tank as necessary.

The two existing 150,000-gallon storage tanks are sufficient to store the liquids for a period of time compatible with the selected water handling/treatment method. Periodically, the contents of the water storage tank will be removed for treatment and discharged on-site in accordance with the substantive requirements of applicable federal and state laws and ARARs or, if there is any off-site disposal, in accordance with all requirements of federal and state laws and ARARs for off-site disposal, if any.

The exhaust from the soil vapor vacuum pump system is connected to a two-stage carbon adsorption system (i.e., primary and secondary). This system consists of two vessels in series containing granular activated carbon. The organics contained in the extracted air will be adsorbed on the activated carbon. The moisture content of the air stream will be less than 50% relative humidity, and temperatures will be maintained below 150°F by a cooling system -- both conditions that allow for efficient operation of the carbon adsorption unit.

The vapor from the primary carbon vessel will be monitored frequently by an existing on-line organic analyzer. When the organic analyzer detects organic vapor in the air stream between the primary and secondary carbon vessels, the SVE system will shut down automatically to permit the removal and replacement of the "spent" primary carbon vessel. An operator will be alerted to this condition by the shutdown alarm, and will disconnect the primary carbon bed from service. The spent carbon vessel will be removed and a carbon vessel containing fresh activated carbon will be placed in operation. The unit previously serving as the secondary carbon bed will become the primary carbon bed and the unit just placed in operation will be the secondary carbon bed. Once this switch is complete, the SVE system (i.e., vacuum pump and injection pump) will be restarted and the system operation resumed. The arrangement of two activated carbon vessels in series (i.e., primary and secondary) will permit optimal utilization of the activated carbon, and efficient capture of the organics. The spent carbon vessels will be stored on-site. The inlet and outlet connections to each carbon vessel will be capped and sealed appropriately. Periodically when a truckload quantity of vessels has accumulated, and at the conclusion of the SVE program, the vessels containing the spent carbon will be transported in accordance with the requirements of the applicable federal and state laws and ARARs to an off-site facility where the carbon will be

regenerated by high temperature incineration, and in the process, the organics adsorbed on the carbon will be destroyed.

If the SVE system is shut down due to a combination of: (a) the need to shut down the water treatment system and (b) exceedance of on-site water storage capacity, and the shutdown of the SVE system for that reason continues for more than 5 days in any one month or for more than an average of 3 days per month (using a rolling average and for this purpose an assumed SVE operation time of 1 year), then water generated by the SVE system will be disposed of off-site so as to allow resumption of SVE system operation. Off-site water disposal, if any, will be performed in accordance with all requirements of federal and state laws and regulations and ARARs. Off-site water disposal will terminate as soon as practicable once the on-site treatment system operation and storage capacity allow for resumption of on-site water management. Wastewater discharges and vapor emissions from the existing treatment systems will be monitored to ensure attainment of the standards presented in February 1997 "Briefing Memorandum on ARAR Effluent Limits" prepared by IDEM.

**APPENDIX B**

Thin Barrier Curtain Wall

## THIN BARRIER CURTAIN WALL

A thin barrier curtain wall, to be constructed as part of the Augmented SVE System, will be installed along the east, south, and southwest sides of the ECC Site, adjacent to the SVE trenches (see Figure 2). The thin barrier curtain wall will eliminate, *inter alia*, any connection between the sand lenses in the till unit and the Unnamed Ditch, thus significantly decreasing the volume of water to be removed and treated.

The thin barrier curtain wall will be approximately 1,100 feet long, 4 inches wide, and of varying depth. The proposed location for the thin barrier curtain wall is shown on Figure B-1 and a profile view of the curtain is shown on Figure B-2. It is presently contemplated that the thin barrier curtain wall will be installed using the Vibrated Beam Method,<sup>1</sup> although conventional slurry wall trench construction methods will be considered.<sup>2</sup> The vibrated beam installation technique utilizes a special crane-suspended I-beam connected to a powerful vibrator. The beam is locked in a guide frame for exact positioning and stabilized by a hydraulic foot that provides guidance and aids in keeping the wall vertical. Cement/bentonite slurry is injected under pressure through a set of nozzles located at the base of the vibrated beam. At the completion of each panel, the rig is moved along the direction of the wall, the previous insertion is overlapped to ensure continuity, and the entire process is repeated. The wall is installed with minimal soil excavation requirements.<sup>3</sup> The result is an approximately 4-inch thick wall made of a bentonite and cement mixture, with a resulting permeability of  $1 \times 10^{-7}$  cm/sec or less. A cross-section view of the thin barrier curtain wall is shown on Figure B-3. The thin barrier curtain wall will provide a continuous low permeability boundary, thus blocking flow through the higher permeability sand and gravel lenses in the shallow till.<sup>4</sup> Four sets of piezometers will be installed along the length of the thin barrier curtain wall in order to monitor hydraulic gradients in the till and sand and gravel units. One pair of

---

<sup>1</sup> Patent held by Slurry Systems, Inc. of Gary, Indiana.

<sup>2</sup> If conventional trench construction methods are considered, then construction of a thicker wall will be contemplated. The installation method and design specifications for the thin barrier curtain wall will be presented in the design report.

<sup>3</sup> An approximately 2-foot deep excavation will be required along the length of the excavation trenches. The excavated soil will be placed on the former SCPA following testing to ensure it does not exceed the Soil Concentrations listed in Table Z-1-1. Soil exceeding these standards will be treated on site or disposed of off site according to applicable USEPA and IDEM regulations and ARARs. Details will be presented in the design report.

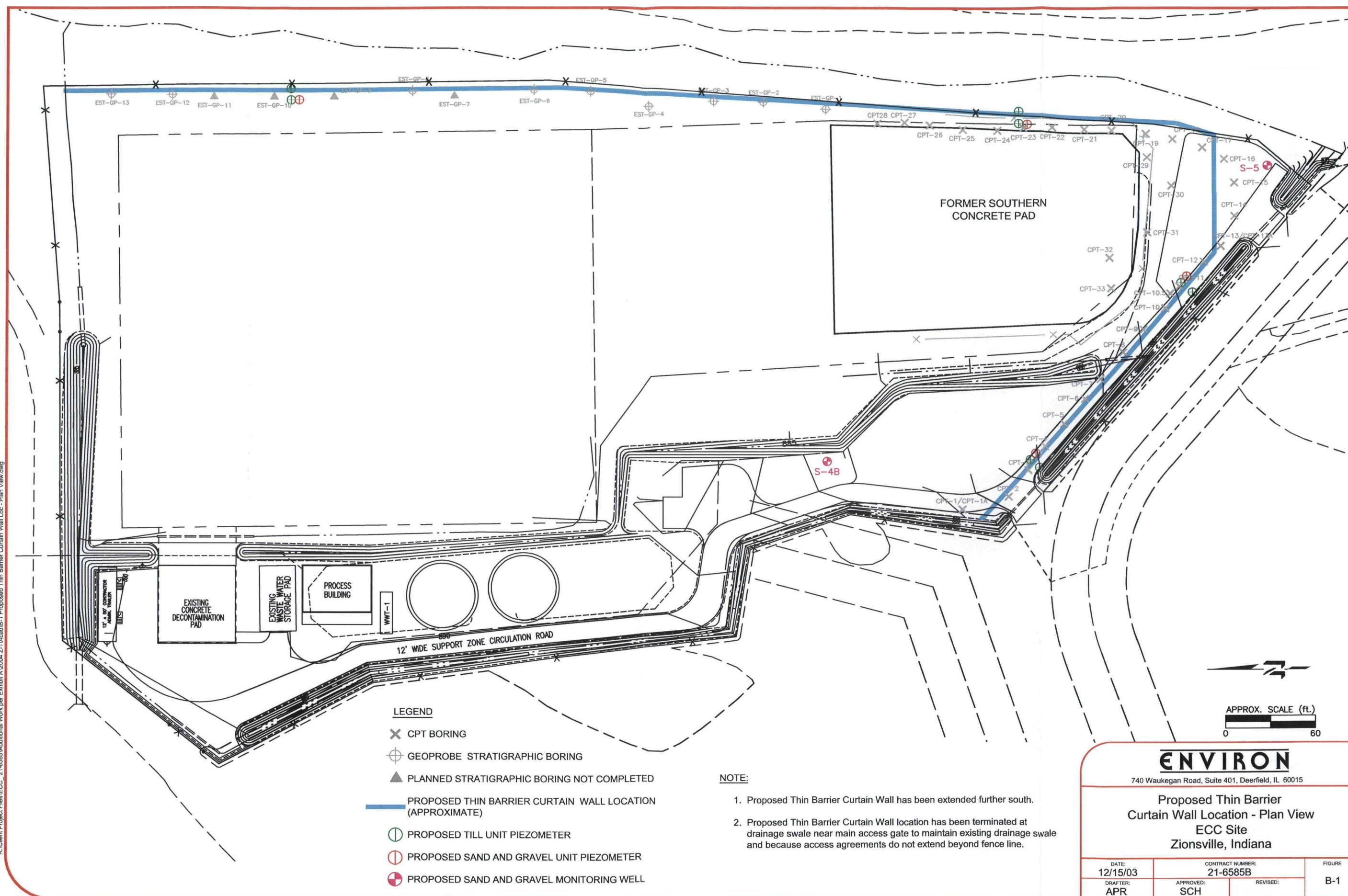
<sup>4</sup> To the extent feasible, the thin barrier curtain wall will not be constructed during the winter months and the construction of the augmented SVE trench system will overlap the construction of the curtain wall.



piezometers for each set will be installed on either side of the thin barrier curtain wall within the till unit. The third piezometer for each set will be installed within the sand and gravel unit, adjacent to the upgradient till unit piezometer. Three of the piezometer sets will be installed in the general areas of T-6, T-8, and T-9. These locations will provide a comparison of historic and post-curtain wall till water levels. The fourth set of piezometers will be installed at the western end of the south trench and will verify that on-site subsurface water is not migrating around the trench.

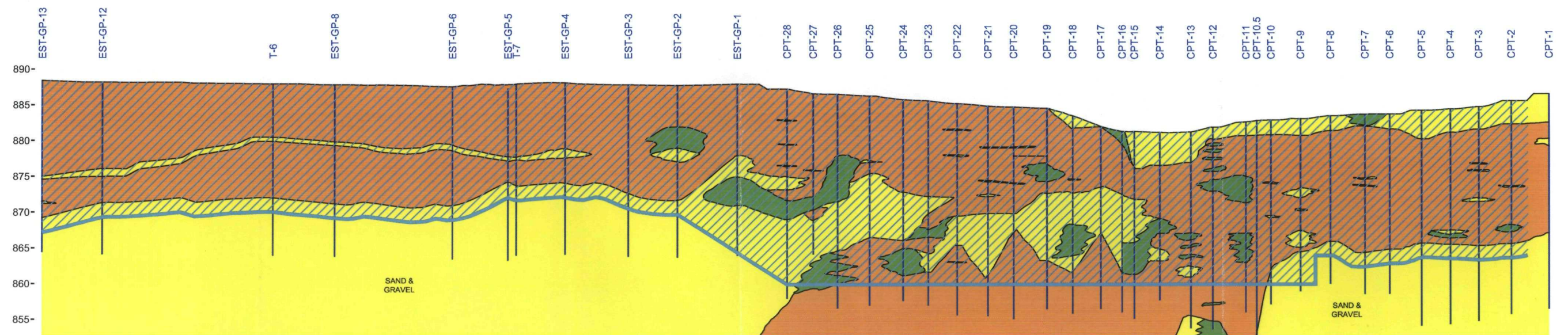
The piezometers will be installed following the construction of the augmented SVE trenches. Construction details will be presented in the design report.

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# LEGEND

— PROPOSED THIN BARRIER CURTAIN WALL LOCATION  
(2 FT INTO TOP OF LOWER SAND & GRAVEL STRATUM (EXCEPT WHERE SHOWN  
AT ELEVATION 860)).

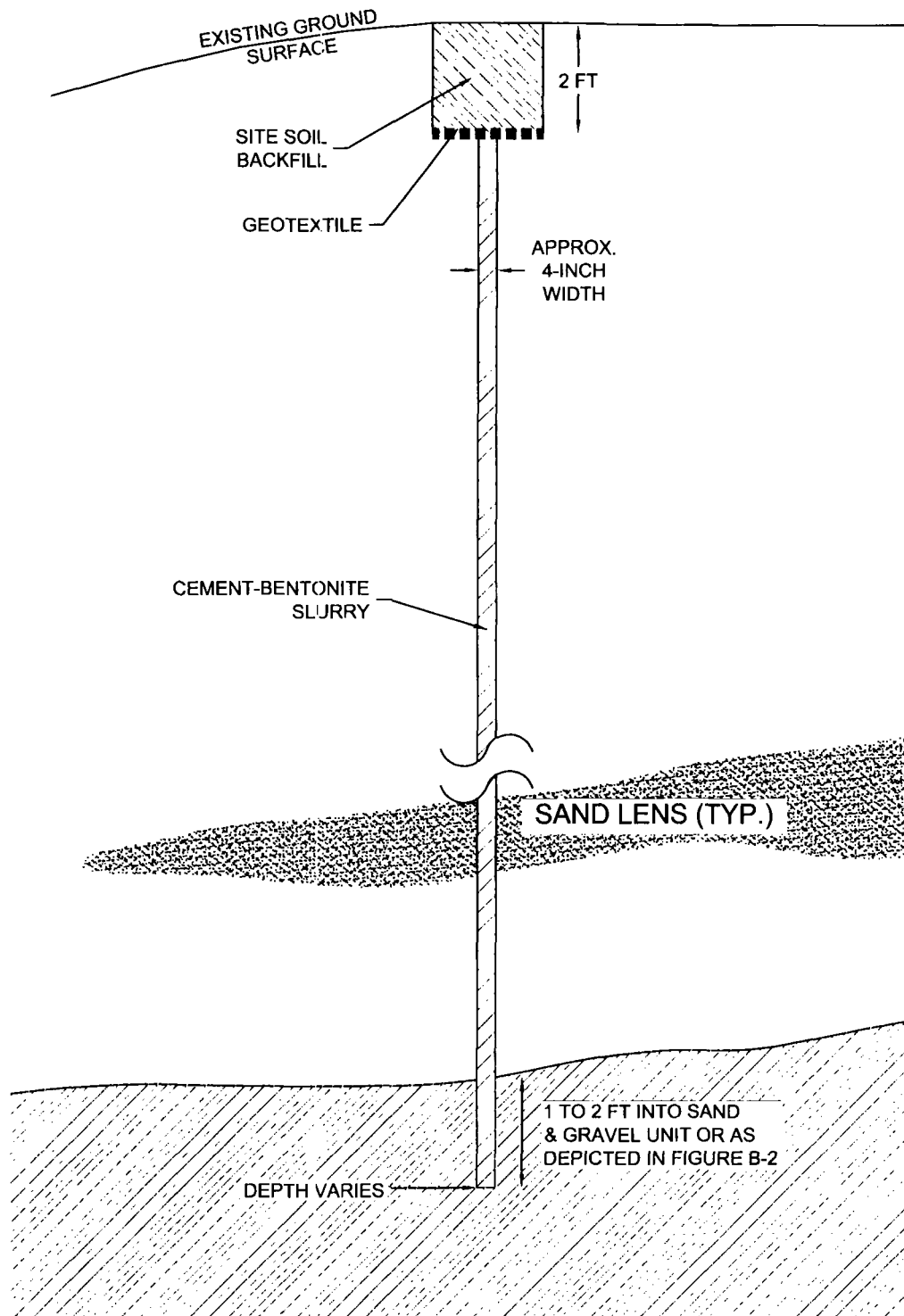
**ENVIRON**

740 Waukegan Road, Suite 401, Deerfield, IL 60015

Thin Barrier Curtain Wall - Profile View  
ECC Site  
Zionsville, Indiana

DATE: 8/26/03	CONTRACT NUMBER: 21-6585B	FIGURE
DRAFTER: APR	APPROVED: SCH	REVISED: B-2

# THIN BARRIER CURTAIN WALL



**ENVIRON**

740 Waukegan Road, Suite 401, Deerfield, IL 60015

Thin Barrier Curtain Wall Typical Section  
ECC Site  
Zionsville, Indiana

Figure  
**B-3**

Drafter: APR

Date: 12/16/03

Contract Number: 21-6585B

Approved: SCH Revised:

R:\Client Project Files\ECC\_21-6585\Additional Work per Exhibit A\2004 2-1\Acad\B-3 Thin Barrier Curtain Wall Typ Section.dwg Sep 03, 2004

## **APPENDIX C**

### **Sampling Plans**

**QUALITY ASSURANCE PROJECT PLAN  
VOLUME II**

**FIELD SAMPLING PLAN**

**REVISED REMEDIAL ACTION**

**FINAL (100 PERCENT) DESIGN  
ENVIRO-CHEM SUPERFUND SITE  
ZIONSVILLE, INDIANA**

**Prepared for:  
Environmental Conservation and  
Chemical Corporation Site Trust Fund**

**Radian Project Number 002455.06**

**Revision 4 , April 28, 1997**

## 6.0 Sampling Procedures and Equipment

Detailed procedures for sample collection and a general description of the proposed sampling equipment are presented in this section. Detailed information pertaining to equipment maintenance and calibration is presented in Volume I of this QAPP. All sampling activities will be documented in the field logbook, as described in Volume I, Section 5.1.2.

### 6.1 Extracted Soil Vapor

Soil vapor samples will be collected from the combined vapor flow prior to entering the activated carbon system and from individual trenches or extraction well laterals for volatile organic compound (VOC) analysis as follows:

- ▶ A calibrated personal sampling pump (whose flow can be determined within  $\pm 5$  percent of the recommended flow rate) will be attached to the sampling tap installed on the SVE system. Appendix F of Volume III provides procedures for calibration of personal sampling pumps;
- ▶ A sampling train of two activated charcoal tubes (known as National Institute for Occupational Safety and Health (NIOSH) tubes - see Appendix C of Volume III) will be connected in series to the personal sampling pump such that the soil vapor is pulled through the tubes before going through the pump;
- ▶ The sample tap valve will be opened;
- ▶ The volume of vapor required to allow attainment of the required method detection limits (10 liters) will be pumped at a flow rate of 0.2 liters per minute for a total of 50 minutes;
- ▶ The sampling tap valve will be closed at the end of the sampling interval;
- ▶ The activated charcoal tubes will be removed, capped, placed in sealable plastic "whirl pak" bags (as supplied by the selected analytical laboratory), and labeled; and
- ▶ The tubes will be carefully packed into new, clean paint cans with loose charcoal in the bottom, which will then be stored in a cooled container, separated from other types of environmental samples.

The phenol vapor samples will be collected as follows:

- ▶ A calibrated personal sampling pump (whose flow rate can be determined within  $\pm 5$  percent of the recommended flow rate) will be attached to the sampling tap on the SVE system;
- ▶ An XAD-7 sorbent tube (see Appendix C of Volume III) will be connected to the personal sampling pump such that the soil vapor is pulled through the tube before going through the pump;
- ▶ The sample tap valve will be opened;
- ▶ The volume of vapor required to allow attainment of the required method detection limits (10 liters) will be pumped at a flow rate of 0.1 liters per minute for a total of 100 minutes;
- ▶ The sampling tap valve will be closed at the end of the sampling interval;
- ▶ The XAD-7 tubes will be removed, capped, placed in sealable plastic whirl pak bags, and labeled; and
- ▶ The tubes will be carefully packed into new, clean paint cans with loose charcoal in the bottom, which will then be stored in a cooled container, separated from other types of environmental samples.

The soil vapor sampling procedures for VOCs and phenol analyses will be modified during the restart spike events by using a flow rate of 0.04 liters per minute for a total of 5 hours, starting 30 minutes after restarting the SVE system [REDACTED]

Decontamination of the vapor sampling equipment will be conducted prior to any sampling and between sampling events by purging the sampling train (except the tubes) with nitrogen to remove any residual extracted soil vapor.

Field blanks will be obtained by drawing ambient air through the decontaminated sampling train and collecting those samples in sample tubes. The number of field blanks to be collected is one field blank per group of 10 or fewer samples. No field blank will be collected for the combined vapor flow sampling (unless the combined vapor sampling coincides with the



individual extraction trenches vapor sampling) because only one sample will be collected approximately 26 times (depending on the duration of SVE operation).

Trip blanks will consist of unbroken activated charcoal tubes that are kept with the VOC samples from individual trenches throughout the sampling event. These unbroken tubes will then be broken at the beginning of the sampling event, capped, packaged for shipment with the other samples, and submitted to the laboratory for analysis. There will be one trip blank included in each sample shipping container. No trip blanks will be collected specifically for the combined vapor flow sampling.

The laboratory will analyze the vapor sample tube to determine if VOCs have been collected on the adsorbent media within the tube.

The selected analytical laboratory will report if any breakthrough is observed in any of the vapor samples. If breakthrough does occur, the sampling rate and/or time of collection will be modified to avoid breakthrough in subsequent samples. However, after the organic levels have decreased as a result of the operation of the SVE, the originally planned sample rates and times should be reinstated.

## **6.2 Soil**

### **6.2.1 SVE Treatment Area Soil**

Soil samples will be collected by using a 2-inch diameter split-spoon sampler at the locations and depths specified by the U.S. EPA and IDEM.

The procedure to obtain soil samples is as follows:

- ▶ A 2-foot by 2-foot hole will be dug by hand into the temporary cover (3 feet of clay and 12 inches of top soil), keeping each cover layer separate;
- ▶ Soil samples will be collected at the specified depths, taking into account the depth of the fill used to grade the site prior to installing the temporary cover; and
- ▶ The temporary cover layers will be replaced.

One duplicate sample will be collected per group of 10 or fewer soil samples. Drilling augers will be steam cleaned between each sampling location, and split-spoon samplers will be steam cleaned and rinsed with distilled water between the collection of each sample. Any other equipment that comes into contact with a sample will be decontaminated as described in Table 6-1.

### **6.2.2 Borrow Area Soils**

The borrow area soils slated for use in the final cover and as backfill for the southern concrete pad excavation will be sampled using a test pit operation procedure where an excavator or backhoe will dig from surface to the intended vertical limit of useable soils. Sampling will include discrete sampling of the soils throughout the vertical profile of the borrow area.

The limits of the useable soils will be determined by the geotechnical soil analysis (e.g. gradation, Atterberg limits, etc.) as specified in the Technical Specifications and as directed by Appendix A of the Construction Quality Assurance Plan (CQAP). The contractor will be responsible for determining the required number of samples based on the number of borrow areas and useable soils configuration (horizontal/vertical) in each. The final number of samples and analyses of borrow soils will be approved by the Engineer prior to the Contractor performing the sampling.

### **6.3 Subsurface Water Sampling**

Samples from the subsurface wells will be collected semiannually during the operation of the SVE system (Soils Cleanup Verification Phase) and analyzed as specified in Section 4.3. Compliance monitoring will be continued on a semiannual basis for 7 years after Soil Cleanup Verification is accomplished [REDACTED]

**Table 6-1. Decontamination Protocol for Sampling Equipment**

Step Number	Description
1	Scrub equipment thoroughly with soft-bristled brush in a low-suds detergent solution.
2	Rinse equipment with tap water by submerging and/or spraying.
3	Rinse equipment with methanol by spraying until dripping; retain drippings.
4	Rinse equipment with distilled water by spraying until dripping; retain drippings.
5	Rinse equipment with distilled water a second time by spraying until dripping; retain drippings.
6	Place equipment on plastic or aluminum foil and allow to air dry for 5 to 10 minutes.
7	Wrap equipment in aluminum foil (shiny side out) for handling and/or storage until next use.

### 6.3.1 Water Level Measurement

Static water levels will be measured to the nearest 0.01 foot in each monitoring well and the piezometer at each sampling event and recorded in the field notebook. The water level surface will be measured prior to well purging and sampling by using an electric water level meter. Before lowering the probe in the well, the batteries will be checked by pressing the test button on the instrument. The probe will be slowly lowered into the well until contact with the water surface is indicated on the meter. The probe will be withdrawn just above the water surface, and a second reading will be taken prior to withdrawing the probe from the well. Both readings will be recorded in the field logbook. The probe will be decontaminated prior to inserting the instrument into a well by washing with a detergent such as Alconox, rinsing with methanol, and rinsing three times with distilled water.

Each well will have a reference point, indicated on the inner well casing, from which water level measurements will be taken. The reference point elevation on the well will be

established by a survey with respect to U.S. Datum mean sea level elevation to an accuracy of 0.01 feet for computation of the subsurface water elevation.

### 6.3.2 Well Depth Measurement

The total depth of the well will be measured and recorded prior to well purging and sampling. A weight tied to a length of cotton cord will be used to tag the bottom of the well, and the length of cord used will be measured to establish well depth. The weight will be rinsed with distilled water and the cotton cord will be replaced between measurements.

### 6.3.3 Well Evacuation

Standing water in the wells will be removed prior to sampling by purging until: (1) at least three well volumes have been removed; (2) the well yields low turbidity water; and (3) consistent values of temperature, pH, and specific conductance are achieved. If the well goes dry before three well volumes have been removed, samples will be taken as soon as the well recovers. The calculation of well volume will be as follows:

- ▶ The well casing inside diameter will be measured;
- ▶ The static water level below the measuring point will be determined;
- ▶ The total depth of the well will be identified from the measuring point;
- ▶ The number of linear feet of static water will be calculated as the total depth of the well minus the static water level; and
- ▶ The static volume (well volume) will be calculated in gallons as:

$$V = (\pi r^2)(h)(7.48)$$

Where:

V = well volume (gal)

$\pi = 3.14$

r = well radius (ft)

h = linear feet of static water (ft)

Dedicated Teflon or stainless steel bailers will be used for purging and sampling the wells. Purged water will be placed in containers for subsequent handling and disposal in accordance with Federal, state, and local regulations based upon the results of chemical analysis. Bailers, pumps, and all other equipment shall be decontaminated prior to insertion into the well. Decontamination will consist of steam cleaning or washing with a detergent such as Alconox, rinsing with methanol, and rinsing three times with distilled water. Bailer ropes and sampling gloves will be discarded after sampling each well.

#### **6.3.4 Groundwater Sampling**

During sampling, special care will be taken to avoid physically altering or chemically contaminating the sample volumes. Sampling of onsite till wells will not occur until the SVE system has been shut down, and till waters have been given sufficient time to stabilize as described in Section 6.3.3.

Sampling will be performed with bottom-filling Teflon or stainless steel bailers. Subsurface water pH, specific conductance, and temperature will be determined in the field on secured samples. Sample volumes will be collected in the following order:

- ▶ Volatile organics;
- ▶ Base neutral/acid extractable organics;
- ▶ Polychlorinated biphenyls (PCBs);
- ▶ Metals; and
- ▶ Cyanide.

Samples of subsurface water will be prepared, preserved, and stored as described in Section 7.0. All sampling equipment will be decontaminated between samples following the procedures in Table 6-1.

The objective of the subsurface water sampling for the metals and PCBs shown in Table 4-3 is to determine the concentration of dissolved constituents. Therefore, subsurface water

samples for metals and PCB analyses will be filtered through a nonmetallic 0.45-micron pore size membrane immediately after collection. One of the following apparatus will be used for field filtration: (1) a Sartorius filtration apparatus or (2) a Nalgene filtration apparatus. If necessary, the sample may be pumped through the filter using a Nalgene hand vacuum pump. The first 150 to 200 ml of filtrate will be used to rinse the filtration apparatus of any contaminants. This technique minimizes the risk of altering the composition of the samples by the filtering operation. The filtrate for metals analysis will be collected in a polyethylene bottle and immediately acidified to a pH <2 using nitric acid. The filtrate for chromium VI analysis will not be acidified. The filtrate for PCB analysis will be collected in amber glass bottles.

One field blank sample will be collected for each group of 10 or fewer samples. Equipment in safe blank samples will be prepared immediately after collection of a field sample by pouring distilled water through a decontaminated bailer into the appropriate sample container. Preparation of the field blank will occur onsite.

One field duplicate sample will be obtained for each group of 10 or fewer compliance samples.

Matrix spike/matrix spike duplicate (MS/MSD) samples will be collected at a frequency of one per group of 20 or fewer compliance samples designated for organics analysis.

Trip blank samples will be provided by the laboratory selected to perform volatile organic analysis at a frequency of one per shipping container of samples.

#### **6.4 Surface Water**

The surface water will be monitored by sampling the unnamed ditch just upstream and just downstream of the ECC Site (Figure 4-1). To collect a surface water sample, the sample container will be submerged in the water, removed, and immediately capped. The container mouth will be positioned so that it faces upstream, while the sampling personnel are standing downstream to prevent the stirring up of any sediments that would contaminate the sample. Downstream samples will be collected first moving upstream. Quality control samples (field blanks, field duplicates, and MS/MSD samples) will be collected at the same frequency as specified for subsurface water samples. Decontamination of sampling equipment will consist of

washing with a detergent such as Alconox, rinsing with methanol, and rinsing three times with distilled water.



Transmitted Via Facsimile

31 October 2000

Mr. Michael McAteer  
USEPA  
HSEW-6J  
77 West Jackson Blvd.  
Chicago, Illinois 60604-3590

Mr. Myron Waters  
IDEM  
100 North Senate Ave.  
P.O. Box 6015  
Indianapolis, IN 46206-6015

Re: Revised Remedial Action (RRA) at the Enviro-Chem Site, Zionsville, Indiana  
Soil Vapor Extraction System Sampling Protocol (SVESSP)

Dear Mr. McAteer:

On September 20, 2000, Versar, Inc. (Versar) participated in a conference call with the U.S. Environmental Protection Agency (USEPA) and CH2M Hill, Inc. (CH2M Hill) to discuss the Soil Vapor Extraction System Sampling Procedures (SVESSP) and requirements for the Enviro-Chem site in Zionsville, Indiana. During the call the following items were discussed:

- The SVESSP modified by Versar from the protocol established in the 100% RRA Final Design Report
- A second round of Soil Vapor Extraction (SVE) sampling data required to confirm that individual trench sampling does not exceed the criteria identified in Table 4.1, Revised Exhibit A
- Restart spike sampling
- Soil sampling after the restart spike sampling is completed

**Modified SVESSP**

The vapor sampling procedure identified in the 100% RRA Final Design Report (100% RRA FDR) Volume 2, QAPP/Field Sampling Plan, Section 6.1, *Extracted Soil Vapor* (applicable pages attached) for operational control of the SVE system was not implementable due to operational constraints. The operational constraints resulted from the high vacuum pressure (i.e., 10 inches of Hg) that exists in the SVE piping manifolds. The high vacuum pressure cannot be overcome with the specified personal sampling pump (i.e., maximum vacuum pressure of 2.2 inches of Hg).

After discussion with USEPA, IDEM, and CH2M Hill, Versar implemented a modified procedure for the routine collection of vapor samples for the purposes of operational monitoring. This procedure has been used for more than 20 months. An overview of the procedure follows:



- Pump-out any standing water in the manifold system and continuously operate the system for at least 48 hours prior to any sampling
- Determine the air flow rate at the manifold sampling port utilizing a Dwyer thermal anemometer
- Collect a vapor sample in a 12-liter Tedlar bag utilizing a high vacuum pump
- Attach a personal sampling pump to the Tedlar bag and follow the procedure identified in the 100% RRAFDR, Volume 2, QAPP/Field Sampling Plan, Section 6.1, *Extracted Soil Vapor*.

The use of the high vacuum pump to extract the vapor sample overcomes the operational constraints while utilizing the remainder of the procedure as specified in the 100% RRAFDR Volume 2, QAPP/Field Sampling Plan, Section 6.1, *Extracted Soil Vapor*. Attached is a Proposed Revision to Section 6.1 that details the procedure.

#### **Second Round of SVE Sampling**

##### *Attachment Z-1*

██████████ requires a second confirmatory round of sampling from all trenches. This sampling event was performed during the week of 2 October 2000. The results of this second round of sampling are being transmitted under separate cover. The results confirm the data obtained for the first round of sampling, i.e., that all contaminant concentrations are below those specified in the Soil Vapor Concentrations In Equilibrium With Acceptable Soil Concentrations. ██████████ Therefore, the system is now ready for the restart spike testing program.

#### **Modification to Restart Spike Sampling**

The discussion focused on the specific location in the SVE system to use for collecting vapor samples and the techniques that will be used for sampling. Locations on both the inlet and discharge sides of the vacuum pump were considered. Subsequently, it was determined that the ambient air bleed at the inlet of the pump cannot be closed without causing the pump to overheat during the five-hour sampling period. If the bleed air valve remains open, the discharge vapor stream will be diluted, yielding erroneous data. Therefore, Versar recommends that the restart spike sampling be performed as follows:

- Locate the sampling point on the inlet side of the vacuum pump before the bleed air is admitted into the system
- Collect vapors directly onto the sorbent by using a high vacuum sampling pump
- Measure the flow rate using a mass flow meter that measures air flow independent of pressure and temperature

The attached Proposed Revision to Section 6.1 details this procedure.

#### Soil Sampling after the Restart Spike Sampling

USEPA and CH2M Hill agree that the vapor sampling of the trenches and the restart spikes themselves are solely indicators of the equilibrium that exists between the vapors and the soil. The required soil sampling after the restart spike sampling will ultimately determine whether the soil in SVE Treatment area has been remediated. USEPA/CH2M Hill will be selecting the location of soil samples to satisfy two objectives: (1) sampling of the entire SVE treatment area; and (2) hot spot evaluation based upon the operational vapor analysis performed earlier by Versar.

Versar should have the second round of SVE vapor sampling data available during the week of 30 October 2000 and will formally request that the restart spike sampling be scheduled with distribution of this data.

Please contact me at (215) 788-7844, extension 222 should you have any comments or require further clarification of the restart spike sampling procedures.

Very truly yours,

*Charles J. Anastos*  
*for*

G. J. Anastos, Ph.D., PE  
Project Manager

Attachments

cc: D. Ashline  
R.O. Ball  
N.W. Bernstein  
C. Gaffney  
T. Harrison

# ENVIRON

November 10, 2000

Via Facsimile and Federal Express

Mr. Michael McAteer  
U.S.EPA, HSRW-6J  
77 West Jackson Blvd.  
Chicago, IL 60604-3590

Re: Low Flow Ground Water Sampling  
ECC Superfund Site  
Zionsville, Indiana

Dear Mr. McAteer:

The purpose of this letter is to propose changes in the methodology for the purging and sampling of the till wells at the ECC Superfund Site in Zionsville, Indiana. For the past six sampling events, the ground water samples from the till wells were collected as described in Section 6.3 of the Radian Revised Remedial Action Field Sampling Plan, Revision 4, dated April 28, 1998 (FSP). In accordance with the FSP, the till wells were purged of a minimum of three well volumes or until the wells went dry, prior to sampling. The water in the till monitoring wells was evacuated using dedicated polyethylene disposable bailers and sampled using dedicated Teflon disposable bailers.

As stated within each of the quarterly and semi-annually sampling reports, most of the till wells were purged (bailed) dry before the three well volumes could be removed. In addition, the purging and sampling with a bailer increased the turbidity of the purge and sample water. ENVIRON believes that sampling procedures that cause less disturbance, and therefore less turbidity, produce the most reproducible and representative samples.

In an effort to decrease the turbidity of the purge and sample water and to limit the number of wells that are being purged dry, ENVIRON is proposing low flow purge and sampling methods for all ten ECC till wells. The six off-site till wells would be purged and sampled using the same methodology as is used to purge and sample the sand and gravel wells. This method involves the use of a peristaltic pump and dedicated Teflon tubing to sample the wells after three well volumes had been purged with a peristaltic pump. The intake for the Teflon tubing would be placed at the bottom of the screened interval and the pump would be set to its lowest flow rate.

The four on-site till wells will be purged and sampled using dedicated PVC bladder pumps and dedicated Teflon tubing. Because the on-site till wells are screened at a greater depth below the present ground surface than the off-site till wells (due to the

November 10, 2000

placement of the contaminated fill from the Southern Pad area as well as the placement of the RCRA cover in this area) the depth to the bottom of the screened interval is to great for the use of a peristaltic pump. In addition, the bladder pumps will provide a pump rate even lower than the peristaltic pumps, thus further decreasing the turbidity of the sample.

With your approval, ENVIRON expects to conduct the Fourth Quarter 2000 ground water sampling, using the above mentioned low flow sampling methods, during the week of November 27, 2000.

If you have any questions, please do not hesitate to contact us.

Sincerely,

ENVIRON International Corporation



Scott Hayter, P.G.  
Senior Associate

SH

cc: Mr. Myron Waters - IDEM  
Mr. Tim Harrison - CH2M Hill  
Dr. Roy Ball - ENVIRON International Corporation  
Mr. Norman Bernstein - N. W. Bernstein & Associates, L.L.C.

## **A P P E N D I X D**

### **IDEM RISC Default Equations and Parameters**

**Table C**

Exposure Equations

Equation Number	Equation Name	Table C - Exposure Equations
A1-1	Residential Groundwater (Carcinogens)	$C_{gwc} = \frac{TR \times BW_b \times AT_c \times 365 \frac{\text{day}}{\text{year}}}{EF_r \times ED_r \times \left[ (SF_o \times \text{IngR}_{rsw}) + (SF_i \times \text{InhR}_{ras} \times K) \right]}$
A1-2	Residential Groundwater (Non-carcinogens)	$C_{gwn} = \frac{THQ \times BW_b \times AT_n \times 365 \frac{\text{days}}{\text{year}}}{EF_r \times ED_r \times \left[ \left( \frac{\text{IngR}_{rsw}}{RFD_o} \right) + \left( \frac{\text{InhR}_{ras}}{RFD_i} \times K \right) \right]}$
A1-3	Residential Soil Direct Contact (Carcinogens)	$C_{src} = \frac{TR \times AT_c \times 365 \frac{\text{days}}{\text{year}}}{EF_r \times \left[ \frac{SF_o \left( \text{IngF}_{adj} + \left( \frac{SFS_{adj} \times ABS}{10^6 \frac{\text{mg}}{\text{kg}}} \right) \right)}{10^6 \frac{\text{mg}}{\text{kg}}} + \text{InhF}_{adj} \times SF_i \left( \frac{1}{VF} + \frac{1}{PEF} \right) \right]}$
A 1-4	Residential Direct Contact (Non-carcinogens)	$C_{srcn} = \frac{THQ \times AT_n \times 365 \frac{\text{days}}{\text{year}}}{EF_r \times \left[ \left( \frac{\text{IngF}_{adj} + \left( \frac{SFS_{adj} \times ABS}{RFD_o \times 10^6 \frac{\text{mg}}{\text{kg}}} \right)}{RFD_o \times 10^6 \frac{\text{mg}}{\text{kg}}} \right) + \frac{\text{InhF}_{adj}}{RFD_i} \left( \frac{1}{VF} + \frac{1}{PEF} \right) \right]}$
A 1-5	Residential Soil Migration to GW (Carcinogens)	$C_{absrc} = C_{gwc} \times 20 \left[ K_d + \frac{\theta_{wp} + (\theta_{so} \times H')}{\rho_b} \right]$

Equation Number	Equation Name	Table C - Exposure Equations
A 1-6	Residential Soil Migration to GW (Non-carcinogens)	$C_{abn1} = C_{gwn} \times 20 \left[ K_d + \frac{\theta_{wp} + (\theta_{ap} \times H')}{\rho_b} \right]$
A 1-7	Commercial / Industrial Groundwater (Carcinogens)	$C_{gvic} = \frac{TR \times BW_a \times AT_c \times 365 \text{ days/year}}{EF_i \times ED_i \times (SF_o \times \text{Ingr}_{iaw})}$
A 1-8	Commercial/ Industrial Groundwater (Non-carcinogens)	$C_{gwin} = \frac{THQ \times BW_a \times AT_n \times 365 \text{ days/year}}{EF_i \times ED_i \left( \frac{\text{Ingr}_{iaw}}{RFD_o} \right)}$
A 1-9	Commercial/Industrial Soil Direct Contact (Carcinogens)	$C_{soic} = \frac{TR \times BW_a \times AT_c \times 365 \text{ days/year}}{EF_i \times ED_i \left[ SF_o \times \left( \frac{\text{Ingr}_{ias} + (SA_{ias} \times M \times ABS)}{10^6 \text{ mg/kg}} \right) + SF_i \times \text{InhR}_{iaa} \left( \frac{1}{VF} + \frac{1}{PEF} \right) \right]}$
A1-10	Commercial/ Industrial Soil Direct Contact (Non-carcinogens)	$C_{soin} = \frac{THQ \times BW_a \times AT_n \times 365 \text{ days/year}}{EF_i \times ED_i \left[ \frac{(\text{Ingr}_{ias} + (SA_{ias} \times M \times ABS))}{RFD_o (10^6 \text{ mg/kg})} + \frac{\text{InhR}_{ias}}{RFD_i} \left( \frac{1}{VF} + \frac{1}{PEF} \right) \right]}$



Equation Number	Equation Name	Table C - Exposure Equations
A1-11	Commercial/ Industrial Soil Migration to GW (Carcinogens)	$C_{\text{plastic}} = C_{\text{gwic}} \times 20 \left[ K_d + \frac{\theta_{\text{wp}} + (\theta_{\text{ap}} \times H')}{\rho_b} \right]$
A 1-12	Commercial/Industrial Migration to GW Contact (Non-carcinogens)	$C_{\text{sbun}} = C_{\text{gwic}} \times 20 \left[ K_d + \frac{\theta_{\text{wp}} + (\theta_{\text{ap}} \times H')}{\rho_b} \right]$
A 1-13	Construction Soils (Carcinogens)	$C_{\text{sec}} = \frac{TR \times BW_s \times AT_c \times 365 \text{ days/year}}{EF_{\text{co}} \times ED_{\text{co}} \left[ SF_o \times \frac{(\text{IngR}_{\text{cas}} + (SA_{\text{cas}} \times M \times \text{ABS}))}{10^6 \text{ mg/kg}} + SF_i \times \text{InhR}_{\text{cas}} \left[ \frac{1}{VF} + \frac{1}{PEF} \right] \right]}$
A 1-14	Construction Soils (Non-carcinogens)	$C_{\text{secn}} = \frac{THQ \times BW_s \times AT_n \times 365 \text{ days/year}}{ED_{\text{co}} \times EF_{\text{co}} \left[ \frac{(\text{IngR}_{\text{cas}} + (SA_{\text{cas}} \times M \times \text{ABS}))}{RFD_o (10^6 \text{ mg/kg})} + \frac{\text{InhR}_{\text{cas}}}{RFD_i} \left[ \frac{1}{VF} + \frac{1}{PEF} \right] \right]}$

Equation Number	Equation Name	Table C - Exposure Equations
A 1-15	Volatilization Factor	$VF = \frac{\frac{Q}{C_{vf}} \times (3.14 \times D_a \times T)^{\frac{1}{2}} \times 10^{-4} \frac{m^3}{cm^3}}{(2 \times \rho_b \times D_a)}$ <p>Where:</p> $D_a = \frac{\left[ \frac{(\theta_{avf}^{10/3} D_i H' + \theta_{wvf}^{10/3} D_w)}{n^2} \right]}{\rho_b K_d + \theta_{wvf} + \theta_{avf} H'}$
A 1-16	Particulate Emission Factor Equation	$PEF = \frac{Q}{C_p} \times \left[ \frac{3,600 \text{ s/h}}{0.036 \times (1 - V) \times \left( \frac{U_m}{U_t} \right)^3 \times F(x)} \right]$
A 1-17	Ingestion Soil - Age Adjusted	$IngF_{adj} \frac{\text{mg} \cdot \text{yr}}{\text{Kg} \cdot \text{day}} = \frac{ED_{ch} \times IngR_{ras}}{BW_c} + \frac{(ED_r - ED_{ch}) \times IngR_{ras}}{BW_i}$
A 1-18	Skin Contact - Age Adjusted	$SFS_{adj} \frac{\text{mg} \cdot \text{yr}}{\text{Kg} \cdot \text{day}} = \frac{ED_{ch} \times M \times SA_{ras}}{BW_c} + \frac{(ED_r - ED_{ch}) \times M \times SA_{ras}}{BW_i}$

Equation Number	Equation Name	Table C - Exposure Equations
A 1-19	Inhalation - Age Adjusted	$\text{InhF}_{\text{adj}} \frac{\text{M}^3 - \text{yr}}{\text{Kg} - \text{day}} = \frac{\text{ED}_{\text{ch}} \times \text{InhR}_{\text{ca}}}{\text{BW}_c} + \frac{(\text{ED}_r - \text{ED}_{\text{ch}}) \times \text{InhR}_{\text{ra}}}{\text{BW}_r}$
7-1	Soil to Groundwater Partitioning Model	$\text{CCL} = C_w \times \text{DAF} \times \left[ K_d + \frac{\theta_w + \theta_s H'}{\rho_b} \right]$
7-3	Soil Saturation Limit Equation	$C_{\text{sat}} = \frac{S}{\rho_b} (K_d \rho_b + \theta_w + H' \theta_s)$
7-4	Soil Attenuation Capacity	Site Specific Soil Attenuation Capacity = $f_{\text{oc}} \times 10^6$

**TABLE D**

Equation Parameters/Exposure Assumptions

Symbol	Parameter	Value
$\theta_{ap}$	Air Filled Soil Porosity Partitioning model	0.134 l air/l soil
$\theta_{avf}$	Air Filled Soil Porosity - volatilization	0.284 l air /l soil
$\theta_{wp}$	Water Filled Soil Porosity Partitioning model	0.3 l water/l soil
$\theta_{wvf}$	Water Filled Soil Porosity - volatilization	0.15 l water /l soil
ABS	Skin Absorbance Factor (Absorbed fraction)	Chemical Specific (unitless see Table B)
$AT_c$ $AT_n$	Averaging Time (subscript dictates chemical type)	C = 70 Years carcinogens N = 30 Years residential non-carcinogens 25 years industrial noncarcinogens 1 year construction noncarcinogens
$BW_a$	Body Weight Adult	70 kg
$BW_c$	Body Weight Child	15 kg
C	Carcinogen	Chemical Specific
CCL	Carcinogen Closure Level	Chemical Specific
$C_{gw,c}$	Default Level Groundwater Concentration for Residential Carcinogen	Chemical Specific (mg/l)
$C_{gw,n}$	Default Level Groundwater Concentration for Residential Non-carcinogen	Chemical Specific (mg/l)
$C_{igwc}$	Default Level Commercial/Industrial Groundwater Concentration for Carcinogen	Chemical Specific mg/l
$C_{igwn}$	Default Level Commercial/Industrial Groundwater Concentration for Non-carcinogen	Chemical Specific mg/l
$C_{sat}$	Soil Saturation Limit	Chemical Specific (mg/kg)
$C_{sbr,c}$	Subsurface Soil Residential Carcinogen	Chemical Specific (mg/kg)
$C_{sbr,n}$	Subsurface Soil Residential Non-carcinogen	Chemical Specific (mg/kg)
$C_{sbsic}$	Default Closure Level Subsurface Soil Commercial/Industrial Carcinogen	Chemical Specific (mg/kg)

Symbol	Parameter	Value
$C_{sbsin}$	Default Closure Level Subsurface Soil Commercial/Industrial Non-carcinogen	Chemical Specific (mg/kg)
$C_{scc}$	Default Closure Level Soil Concentration Construction Carcinogenic	Chemical specific (mg/kg)
$C_{scn}$	Default Closure Level Soil Concentration Construction Non-carcinogenic	Chemical specific (mg/kg)
$C_{ssic}$	Default Closure Level Surface Soil Commercial/Industrial Carcinogen	Chemical Specific (mg/kg)
$C_{ssin}$	Default Closure Level Surface Soil Commercial/Industrial Non-carcinogen	Chemical Specific (mg/kg)
$C_{ssrc}$	Default Closure Level Residential Surface Soil Concentration Carcinogenic (direct contact)	Chemical specific (mg/kg)
$C_{ssm}$	Default Closure Level Residential Surface Soil Concentration Non-carcinogenic (direct contact)	Chemical specific (mg/kg)
$D_a$	Apparent Diffusivity	Chemical Specific $cm^2/s$
$D_i$	Diffusivity in Air	Chemical Specific $cm^2/s$
$D_w$	Diffusivity in Water	Chemical Specific $cm^2/s$
$ED_{ch}$	Exposure Duration Child	6 years
$ED_{co}$	Exposure Duration Construction	1 year
$ED_i$	Exposure Duration Commercial/Industrial	25 years
$ED_r$	Exposure Duration Residential	30 years
$EF_{co}$	Exposure Frequency Construction	45 days
$EF_i$	Exposure Frequency Commercial/Industrial	250 days/yr
$EF_r$	Exposure Frequency Residential	350 days/year
$EF_{rs}$	Exposure Frequency Residential Soil	250 days/year
$F(x)$	Function dependent on $U_m/U_t$	0.194 (unitless)
$f_{oc}$	Fraction Soil Organic Carbon (Fraction)	0.002 for subsurface soil 0.006 for surface soil

Symbol	Parameter	Value
H	Henry's Law Constant x 41	Chemical Specific (unitless)
IngF <sub>adj</sub>	Ingestion Factor Soil Age Adjusted	114 mg-yr/kg-day
IngR <sub>cas</sub>	Ingestion Rate Construction Adult Soil	480 mg/day
IngR <sub>ias</sub>	Ingestion Rate Commercial/Industrial Adult Soil	50 mg/day
IngR <sub>gaw</sub>	Ingestion Rate Commercial/Industrial Adult Water	1.0 l/day
IngR <sub>ras</sub>	Ingestion Rate Residential Adult Soil	100 mg/day
IngR <sub>raw</sub>	Ingestion Rate Residential Adult Water	2.0 l/day
IngR <sub>rcs</sub>	Ingestion Rate Residential Child Soil	200 mg/day
InhF <sub>adj</sub>	Inhalation Factor Age Adjusted	10.9 m <sup>3</sup> -yr/kg-day
InhR <sub>caa</sub>	Inhalation Rate Construction Adult Air	20 m <sup>3</sup> /day
InhR <sub>iaa</sub>	Inhalation Rate Commercial/Industrial Adult Air	20 m <sup>3</sup> /day
InhR <sub>raa</sub>	Inhalation Rate Residential Adult Air	15 m <sup>3</sup> /day Indoor 20 m <sup>3</sup> /day Outdoor
InhR <sub>raa</sub>	Inhalation Rate Residential Child Air	10 m <sup>3</sup> /day
K	Indoor Volatilization Factor (Inhalation from volatiles in groundwater)	0.5 (unitless)
K <sub>d</sub>	Soil/Water Partition Coefficient(See Table B) K <sub>d</sub> = Table Values for Metals(See Table B) K <sub>d</sub> = K <sub>oc</sub> x f <sub>oc</sub> for Organics(See Table B)	Chemical Specific (l/kg) Chemical Specific (l/kg) Chemical Specific (l/kg)
K <sub>oc</sub>	Soil Organic Carbon/Water Partition Coefficient(See Table B)	Chemical Specific (l/kg)
l	Length of sampling interval	site specific
M	Soil to Skin Adherence Factor	0.5 mg/cm <sup>2</sup> -day
n	Number of site samples	Chemical Specific
NC	Non-carcinogen	Chemical Specific
NCL	Non-carcinogen Closure Level	Chemical Specific

Symbol	Parameter	Value
$P_b$	Dry Soil Bulk Density	1.5 kg/l
PEF	Particulate Emission Factor (See Table C)	$1.316 \times 10^9 \text{ m}^3/\text{kg}$
$P_s$	Soil particle density	$2.65 \text{ g/cm}^3$
$Q/C_{vf}$	Inverse of the mean concentration at the center of a 0.5 acre source - volatilization factor	$68.81 \frac{\text{g/m}^2\text{-s}}{\text{kg/m}^3}$
$Q/C_p$	Inverse of the mean concentration at the center of a 0.5 acre source - particulates	$90.80 \frac{\text{g/m}^2\text{-Sec}}{\text{kg/m}^3}$
$RFD_i$	Reference Dose Inhalation	Chemical Specific (mg/Kg - day)
$RFD_o$	Reference Dose Oral	Chemical Specific (mg/Kg - day)
s	Standard deviation of site sample set	Chemical Specific
S	Solubility in Water	Chemical Specific (mg/l-water)
$SA_{cas}$	Surface Area Construction Exposed Adult Skin	$3160 \text{ cm}^2$
$SA_{ias}$	Surface Area Commercial/Industrial Exposed Adult Skin	$3160 \text{ cm}^2$
$SA_{ras}$	Surface Area Residential Exposed Adult Skin	$5000 \text{ cm}^2$
$SA_{rcs}$	Surface Area Residential Exposed Child Skin	$2000 \text{ cm}^2$
$SF_i$	Carcinogenic Potency Slope Inhalation	Chemical Specific $\frac{(\text{mg/Kg - day})}{1}$
$SF_o$	Carcinogenic Potency Slope Oral	Chemical Specific $\frac{(\text{mg/Kg - day})}{1}$
$SFS_{adj}$	Skin Factor Soil Age Adjusted (See Table C)	1257 mg-yr/kg-day
t	Students' t value corresponding to n at the 95% confidence level (one tailed test)	Chemical Specific
T	Exposure interval Volatilization Equation	$9.5 \times 10^8 \text{ s}$
THQ	Target Hazard Quotient	1 (unitless)
TR	Target Risk	$1 \times 10^{-5}$ (unitless)
$U_m$	Mean annual wind speed	4.69 m/s
$U_t$	Equivalent threshold value of wind speed at 7 m	11.32 m/s
V	Fraction of vegetative cover	0.5 (unitless, = 50%)



<b>Symbol</b>	<b>Parameter</b>	<b>Value</b>
VF	Volatilization Factor (See Table C)	Chemical Specific m <sup>3</sup> /kg
— x	Average of site samples	Chemical Specific

**TABLE F**

Human Health Toxicity Parameters

Appendix 1  
Default Closure Tables

Chemical	CAS	Chronic Sfo (mg/kg-day) <sup>-1</sup>		Chronic Rfdo mg/kg-day		Chronic SFi (mg/kg-day) <sup>-1</sup>		Chronic RfDi mg/kg-day		Sub-Chronic RfDo mg/kg-day		Sub-Chronic RfDi mg/kg-day	
		Value	Source	Value	Source	Value	Source	Value	Source	Value	Source	Value	Source
Acenaphthene	83-32-9			0.06	I			0.06	6,9 (R)				
Acenaphthylene	208-56-8			0.0071	S			0.01	S				
Acetone (2-Propanone)	67-64-1			0.9	I			0.1	6,9 (R)				
Acrolein	107-02-8			0.0005	I			0.0000057	I				
Aldrin	309-00-2	17	I	0.00003	I	17	I	0.00003	6,9 (R)	0.00003	H	0.00003	H
Anthracene	120-12-7			0.3	I			0.3	6,9 (R)	3	H		
Antimony and compounds	7440-36-0			0.0004	I								
Arsenic	7440-38-2	1.5	I	0.0003	I	15	I			0.0003	H		
Barium	7440-39-3			0.07	I			0.000143	H				
Benzene	71-43-2	0.055	I	0.004	I	0.029	3,9	0.0086	I				
Benzo(a)anthracene	56-55-3	0.73	3,6,9 (N)			0.31	6(N)						
Benzo(a)pyrene	50-32-8	7.3	I			3.1	3,6 (N), N						
Benzo(b)fluoranthene	205-99-2	0.73	3,6,9 (N)			0.31	6(N)						
Benzo(g,h,i)perylene	191-24-2	0.073	IDEM			0.031	IDEM						
Benzo(k)fluoranthene	207-08-9	0.073	3,6,9 (N)			0.031	6(N)						
Benzoic acid	65-85-0			4	I			4	9(R)				
Benzyl Alcohol	100-51-6			0.3	H			0.3	6,9 (R)				
Beryllium and compounds	7440-41-7			0.002	I	8.4	I	0.0000057	I				
Bis(2-chloro-1-methylethyl) ether	108-60-1	0.07	9	0.04	9(I)	0.035	9	0.04	9(R)				
Bis(2-Chloroethyl)ether	111-44-4	1.1	I			1.2	I						
Bis(2-chloroisopropyl)ether	39638-32-9	0.07	9	0.04	9(I)	0.035	9	0.04	9(R)	0.04	H	0.04	R
Bis(2-ethylhexyl)phthalate	117-81-7	0.014	I	0.02	I	0.014	3(N) 6,9 (R)	0.022	6,9 (R)				
Bromodichloromethane	75-27-4	0.062	I	0.02	I	0.062	6,9 (R)	0.02	6,9 (R)				
Bromoform(tribromomethane)	75-25-2	0.0079	I	0.02	I	0.0039	I	0.02	6,9 (R)				
n-Butanol	71-36-3			0.1	I			0.0026	9(N)				
Butylbenzylphthalate	85-68-7			0.2	I			0.2	6,9 (R)				
Cadmium	7440-43-9			0.0005	I	6.3	I	0.000057	6,3 (N)				
Carbazole	86-74-8	0.02	H			0.02	6,9 (R)						
Carbon disulfide	75-15-0			0.1	I			0.2	I				
Carbon tetrachloride	56-23-5	0.13	I	0.0007	I	0.053	I	0.00057	3(N)				
Chlordane	12789-03-6	0.35	I	0.0005	I	0.35	I	0.0002	I				
p-Chloroaniline	106-47-8			0.004	I			0.004	6,9 (R)				
Chlorobenzene	108-90-7			0.02	I			0.017	3,6,9 (N)				
Chloroethane	75-00-3	0.0029	3,6,9 (N)	0.4	3,6,9 (N)	0.0029	6,9 (R)	2.9	I				
Chloroform	67-66-3		I	0.01	I	0.081	I	0.000086	6 (N)				
2-Chloronaphthalene	91-58-7			0.08	I			0.08	6,9 (R)				
2-Chlorophenol	95-57-8			0.005	I			0.005	6,9 (R)	0.05	H	0.05	R
Chromium III	16065-83-1			1.5	I								

**Appendix 1**  
**Default Closure Tables**

Chemical	CAS	Chronic Sfo (mg/kg-day) <sup>-1</sup>		Chronic Rfdo mg/kg-day		Chronic SFi (mg/kg-day) <sup>-1</sup>		Chronic RfDi mg/kg-day		Sub-Chronic RfDo mg/kg-day		Sub-Chronic RfDi mg/kg-day	
		Value	Source	Value	Source	Value	Source	Value	Source	Value	Source	Value	Source
Chromium VI	18540-29-9			0.003	I	290	9I	0.000029	I				
Chrysene	218-01-9	0.0073	3,6,9 (N)			0.0031	6(N)						
Copper	7440-50-8			0.037	6								
Cyanide, Free	57-12-5			0.02	I								
Cyclohexane	110-82-7			1.7	R			1.7	I				
DDD	72-54-8	0.24	I			0.24	6,9 (R)						
DDE	72-55-9	0.34	I			0.34	6,9 (R)						
DDT	50-29-3	0.34	I	0.0005	I	0.34	I	0.0005	6,9 R				
Dibenzo(a,h)anthracene	53-70-3	7.3	3,6,9 (N)			3.1	6(N)						
Dibenzofuran	132-64-9			0.002	3 (N)			0.002	R				
1,2-Dichlorobenzene	95-50-1			0.09	I			0.057	H				
1,3-Dichlorobenzene	541-73-1			0.0009	9(N), N			0.0009	9(N), N				
1,4-Dichlorobenzene	106-46-7	0.024	H	0.03	3,6,9(N)	0.022	3,9 N	0.23	I				
3,3-Dichlorobenzidine	91-94-1	0.45	I			0.45	6,9 (R)						
1,1-Dichloroethane	75-34-3			0.1	H			0.14	H				
1,2-Dichloroethane	107-06-2	0.091	I	0.03	3,9 N	0.091	I	0.0014	3,9 N				
1,1-Dichloroethylene	75-35-4			0.05	I			0.057	I				
cis-1,2-Dichloroethylene	156-59-2			0.01	3,6,9 H			0.01	6,9 (R)				
trans-1,2-Dichloroethylene	156-60-5			0.02	I			0.02	6,9 (R)				
2,4-Dichlorophenol	120-83-2			0.003	I			0.003	6,9 (R)				
2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7			0.01	I			0.01	6,9(R)				
1,2-Dichloropropane	78-87-5	0.068	H	0.0011	6,9 (R)	0.068	6,9 (R)	0.0011	I				
1,3-Dichloropropene	542-75-6	0.1	I	0.03	I	0.014	I	0.0057	I	0.003	H	0.0057	
Dieldrin	60-57-1	16	I	0.00005	I	16	I	0.00005	6,9 (R)				
Diethylphthalate	84-66-2			0.8	I			0.8	6,9 (R)				
2,4-Dimethylphenol	105-67-9			0.02	I			0.02	6,9 (R)				
Dimethylphthalate	131-11-3			10	3,6,9 (H)			10	6,9 (R)				
Di-n-butyl phthalate	84-74-2			0.1	I			0.1	6,9 (R)				
2,4-Dinitrophenol	51-28-5			0.002	I			0.002	6,9 (R)				
Dinitrotoluene mixture	25321-14-6	0.68	I	0.001	H	0.68	6,9 (R)	0.001	R				
Di-n-octyl phthalate	117-84-0			0.02	H			0.02	6 (R)				
Endosulfan	115-29-7			0.006	I			0.006	6,9 (R)				
Endrin	72-20-8			0.0003	I			0.0003	6,9 (R)				
Ethylbenzene	100-41-4			0.1	I			0.29	I				
Fluoranthene	206-44-0			0.04	I			0.04	6,9 (R)				
Fluorene	86-73-7			0.04	I			0.04	6,9 (R)				
alpha-HCH(alpha-BHC)	319-84-6	6.3	I			6.3	I						
beta-HCH(beta-BHC)	319-85-7	1.8	I			1.9	I						

Appendix 1  
Default Closure Tables

Chemical	CAS	Chronic Sfo (mg/kg-day) <sup>-1</sup>		Chronic Rfdo mg/kg-day		Chronic SFi (mg/kg-day) <sup>-1</sup>		Chronic RfDi mg/kg-day		Sub-Chronic RfDo mg/kg-day		Sub-Chronic RfDi mg/kg-day	
		Value	Source	Value	Source	Value	Source	Value	Source	Value	Source	Value	Source
gamma-HCH(Lindane)	58-89-9	1.3	H	0.0003	I	1.3	6,9 (R)	0.0003	6,9 (R)				
Heptachlor	76-44-8	4.5	I	0.0005	I	4.6	I	0.0005	6,9 (R)				
Heptachlor epoxide	1024-57-3	9.1	I	0.00013	I	9.1	I	0.00013	6,9 (R)				
Hexachloro-1,3-butadiene	87-68-3	0.078	I	0.0002	H	0.077	I	0.0002	6,9 (R)				
Hexachlorobenzene	118-74-1	1.6	I	0.0008	I	1.6	I	0.0008	6,9 (R)				
Hexachlorocyclopentadiene	77-47-4			0.006	I			0.000057	I	0.0002	H	0.07	H
Hexachloroethane	67-72-1	0.014	I	0.001	I	0.014	I	0.001	6,9 (R)				
n-Hexane	110-54-3			0.06	H			0.057	I				
Indeno(1,2,3-cd)pyrene	193-39-5	0.73	3,6,9 N			0.31	6(N)						
Iodomethane	74-83-4		I IDEM	0.00421	IDEM								
Isophorone	78-59-1	0.00095	I	0.2	I	0.00095	6,9 (R)	0.2	6,9 (R)				
Lead	7439-92-1												
Mercury and compounds	7439-97-6			0.0003	I			0.000086	I	0.0004	H		
Methoxychlor	72-43-5			0.005	I			0.005	6,9 (R)				
Methyl bromide (bromomethane)	74-83-9			0.0014	I			0.0014	I				
Methyl ethyl ketone (MEK)	78-93-3			0.6	I			1.4	I				
Methyl tertiary butyl ether (MTBE)	1634-04-4	0.0033	9(N)	0.86	9(R)	0.00035	9(N)	0.86	I				
4-Methyl-2-pentanone (MIBK)	108-10-1			0.08	3,6,9 H			0.86	I				
Methylene chloride	75-09-2	0.0075	I	0.06	I	0.0016	I	0.86	H				
2-Methylnaphthalene	91-57-6			0.02	3(N)			0.02	R				
3-Methylphenol (m-cresol)	108-39-4			0.05	I			0.05	6,9 (R)				
4-Methylphenol (p-cresol)	106-44-5			0.005	H			0.005	6,9 (R)				
2-Methylphenol(o-cresol)	95-48-7			0.05	I			0.05	6,9 (R)				
Naphthalene	91-20-3			0.02	I			0.00086	I				
Nickel, soluble salts	various			0.02	I	0.84	I						
2-Nitroaniline	88-74-4			0.000057	6(R)			0.000057	H				
Nitrobenzene	98-95-3			0.0005	I			0.00057	H				
N-Nitrosodi-n-propylamine	621-64-7	7	I			7	6,9 (R)						
N-Nitrosodiphenylamine	86-30-6	0.0049	I			0.0049	6,9 (R)						
PCBs (polychlorinated biphenyls)	1336-36-3	2	I	0.00002	I	2	I	0.00002	R				
Pentachlorophenol	87-86-5	0.12	I	0.03	I	0.12	6,9 (R)	0.03	6,9 (R)				
Phenanthrene	85-01-8			0.003	IDEM			0.003	IDEM				
Phenol	108-95-2			0.3	I			0.3	R				
Pyrene	129-00-0			0.03	I			0.03	6,9 (R)				
Selenium	7782-49-2			0.005	I								
Silver	7440-22-4			0.005	I								
Styrene	100-42-5			0.2	I			0.29	I				
1,1,1,2-Tetrachloroethane	630-20-6	0.026	I	0.03	I	0.026	I	0.03	6,9 (R)				

**Appendix 1**  
**Default Closure Tables**

Chemical	CAS	Chronic Sfo (mg/kg-day) <sup>-1</sup>		Chronic Rfdo mg/kg-day		Chronic SFi (mg/kg-day) <sup>-1</sup>		Chronic RfDi mg/kg-day		Sub-Chronic RfDo mg/kg-day		Sub-Chronic RfDi mg/kg-day	
		Value	Source	Value	Source	Value	Source	Value	Source	Value	Source	Value	Source
1,1,2,2-Tetrachloroethane	79-34-5	0.2	I	0.06	3,6,9(N)	0.2	I	0.06	6,9 (R)				
Tetrachloroethylene (PCB)	127-18-4	0.052	6,9(N)	0.01	I	0.012	6 (N)	0.011	6 (N)				
<b>Thallium (and compounds)</b>	7440-28-0			0.00007	IDEM								
Toluene	108-88-3			0.2	I			0.11	I				
Toxaphene	8001-35-2	1.1	I			1.1	I						
1,2,4-Trichlorobenzene	120-82-1			0.01	I			0.057	H	0.01	H	0.57	H
<b>1,1,1-Trichloroethane</b>	71-55-6			0.28	3,9 (N)			0.63	3,9(N)				
1,1,2-Trichloroethane	79-00-5	0.057	I	0.004	I	0.056	I	0.004	6,9 (R)				
<b>Trichloroethylene (TCE)</b>	79-01-6	0.4	3,6,9 (N)	0.0003	3,6,9 (N)	0.4	3,6,9 (N)	0.01	3,9(N)				
2,4,5-Trichlorophenol	95-95-4			0.1	I			0.1	6,9 (R)				
<b>2,4,6-Trichlorophenol</b>	88-06-2	0.011	I	0.0001	9 (N)	0.011	I	0.0001	9(R)				
<b>2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)</b>	93-76-5			0.01	I			0.01	6,9(R)				
<b>1,2,4-Trimethylbenzene</b>	95-63-6			0.05	3,6,9(N)			0.0017	3,6,9(N)				
<b>1,3,5-Trimethylbenzene</b>	108-67-8			0.05	3,6,9(N)			0.0017	3,6,9(N)				
Vinyl acetate	108-05-4			1	H			0.057	I	1	H	0.057	H
<b>Vinyl chloride (chloroethene)</b>	75-01-4	1.5	I	0.003	I	0.031	I	0.029	I				
<b>Xylene mixed (total)</b>	1330-20-7			0.2	I			0.029	I				
Zinc	7440-66-6			0.3	I								

SFi = Inhalation Slope Factor  
 Sfo = Oral Slope Factor  
 RfDi = Inhalation Reference Dose  
 RfDo = Oral Reference Dose  
 3,6,9 = EPA Regions 3,6,9 Screening Tables

CAS = Chemical Abstract Service  
 H = Heast  
 I = IRIS  
 N = NCEA  
 R = Route to Route Extrapolation

PCB Slope Factor and RfD assume a mixture of PCB congeners including Aroclor 1016 and 1254.

## **A P P E N D I X E**

### **Statistical Evaluation of Background Conditions**

TABLE E-1  
Analytical Results and Calculations  
for Background Wells T-5 and S-1

SAMPLE LOCATION ENVIRON SAMPLE ID COLLECTION DATE COMMENTS <sup>1</sup>	T-5 T5-980831 8/31/1998	T-5 T5-980923 9/23/1998	T-5 T5-981023 10/23/1998	T-5 ECTGWS-01 11/9/98 TO 11/12/1998	T-5 T5-981207 12/7/1998	T-5 T5-990112 1/12-15/99	T-5 ECTGWS-02 2/16-19/99	T-5 T5-990315 3/15-18/99	T-5 T5-990415 4/15-20/99	T-5 ECTGWS-03 5/10-14/99	T-5 T5-990614 6/14-18/99	T-5 T5-990714 7/14-19/99	S-1 S1-980901 9/1/1998 DUPLICATE	S-1 S1-980925 9/25/1998 DUPLICATE	S-1 S1-981026 10/26/1998 DUPLICATE	S-1 ECSGW1-01 11/12/1998 DUPLICATE	S-1 S1-981207 12/7/1998 DUPLICATE	S-1 S1-990112 1/12/1999 DUPLICATE	S-1 ECSGW1-02 2/16/1999 DUPLICATE	S-1 S1-990318 3/18/1999 DUPLICATE	S-1 S1-990420 4/20/1999 DUPLICATE	S-1 ECSGW1-03 5/11/1999 DUPLICATE	S-1 S1-990614 6/14/1999 DUPLICATE	S-1 S1-990714 7/14/1999 DUPLICATE	MEAN CONCENTRATION	ONE STANDARD DEVIATION OF MEAN	TWO STANDARD DEVIATIONS ABOVE MEAN		
Volatile Organic Compounds																													
Acetone	5	5	5	3	1	1	1	1.25	1	1	1	1	5	5	5	1	1	1	1	1.25	1	1	1	1	1	2.1	1.8	5.6	
1,1-Dichloroethene	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	1	0.25	0.25	0.25	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.6	1.8		
1,2-Dichloroethene (total)	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.6	1.7		
Ethylbenzene	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.6	1.7		
Methyl ethyl ketone	5	5	10	1	1	1	1	1.25	1	1	1	1.25	5	5	10	1	1	1	1	1.25	1	1	1	1.25	2.5	2.8	8.0		
Methyl isobutyl ketone	5	5	10	1	1	1.25	1	0.79	1	1	1	1.25	5	5	10	1	1	1.25	1	1.25	1	1	1	1.25	2.5	2.8	8.0		
Methylene Chloride	2.5	190	2.5	1	1	0.25	0.25	0.25	0.25	0.4	1	0.5	2.5	220	2.5	0.5	0.5	0.5	0.25	0.45	0.25	0.7	1	0.25	18	58	133		
Tetrachloroethene	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.6	1.7		
Toluene	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.75	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.7	1.9		
1,1,1-Trichloroethane	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.6	1.7		
1,1,2-Trichloroethane	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.6	1.7		
Trichloroethene	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.5	2.5	0.25	0.25	0.25	0.25	0.25	0.25	0.8	0.25	0.25	0.5	0.6	1.8		
Vinyl Chloride	2.5	2.5	5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	2.5	2.5	5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.0	1.5	4.0		
Xylenes (total)	0.5	0.5	5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.75	0.5	5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.7	1.3	3.4		
Semi-Volatile Organic Compounds																													
Bis (2-ethylhexyl) phthalate	1.4	1.78	1.25	4	5	2	6	1	5	6	5	1	1.25	1.25	1.25	5	4.75	5	5	4.75	1	5	5	5	3.5	1.9	7.3		
1,2-Dichlorobenzene	5.55	7.1	5	5	5	5	6	5	5	6	5	5	5	5	5	5	4.75	5	5	4.75	5	5	5	5	5.2	0.5	6.2		
Diethyl Phthalate	5.55	7.1	5	5	5	5	6	5	5	6	5	5	5	5	5	5	4.75	5	5	4.75	5	5	5	5	5.2	0.5	6.2		
Di-n-butyl phthalate	5.55	7.1	5	5	5	5	6	5	5	6	5	5	5	5	5	5	4.75	5	5	4.75	5	5	5	5	5.2	0.5	6.2		
Isophorone	4.6	6	4.15	5	5	5	6	5	5	6	5	5	4.15	4.1	4.15	5	4.75	5	5	4.75	5	5	5	5	4.9	0.5	6.0		
Naphthalene	5.55	7.1	5	5	5	5	6	5	5	6	5	5	5	5	5	5	4.75	5	5	4.75	5	5	5	5	5.2	0.5	6.2		
Phenol	5.55	7.1	5	5	5	5	6	5	5	2	5	5	5	5	5	5	4.75	5	5	4.75	5	5	5	5	5.0	0.8	6.6		
Polychlorinated biphenyls																													
Aroclor 1016	0.5	0.4	0.5	0.5	0.5	0.5	0.25	0.265	0.235	0.265	0.27	0.295	0.25	0.25	0.25	0.5	0.49	0.5	0.24	0.2475	0.24	0.27	0.245	0.25	0.3	0.1	0.6		
Aroclor 1221	0.5	0.4	0.5	1.0	1.0	1.0	0.5	0.5	0.5	0.5	0.6	0.6	0.25	0.25	0.25	1	0.975	1	0.5	0.495	0.5	0.6	0.5	0.5	0.6	0.3	1.1		
Aroclor 1232	0.5	0.4	0.5	0.5	0.5	0.5	0.25	0.265	0.235	0.265	0.27	0.295	0.25	0.25	0.25	0.5	0.49	0.5	0.24	0.2475	0.24	0.27	0.245	0.25	0.3	0.1	0.6		
Aroclor 1242	0.5	0.4	0.5	0.5	0.5	0.5	0.25	0.265	0.235	0.265	0.27	0.295	0.25	0.25	0.25	0.5	0.49	0.5	0.24	0.2475	0.24	0.27	0.245	0.25	0.3	0.1	0.6		
Aroclor 1248	0.5	0.4	0.5	0.5	0.5	0.5	0.25	0.265	0.235	0.265	0.27	0.295	0.25	0.25	0.25	0.5	0.49	0.5	0.24	0.2475	0.24	0.27	0.245	0.25	0.3	0.1	0.6		
Aroclor 1254	0.5	0.4	0.5	0.5	0.5	0.5	0.25	0.265	0.235	0.265	0.27	0.295	0.25	0.25	0.25	0.5	0.49	0.5	0.24	0.2475	0.24	0.27	0.245	0.25	0.3	0.1	0.6		
Aroclor 1260	0.5	0.4	0.5	0.5	0.5	0.5	0.25	0.265	0.235	0.265	0.27	0.295	0.25	0.25	0.25	0.5	0.49	0.5	0.24	0.2475	0.24	0.27	0.245	0.25	0.3	0.1	0.6		
Inorganics																													
Antimony	0.05	10	2.5	0.85	19.4	0.85	3	1.5	2	0.5	1.7	0.45	25	1.25	1.25	0.425	1.4875	0.8625	0.7	0.25	0.75	0.25	0.25	0.45	3.2	6.2	15.6		
Arsenic	10	10	10	2.3	0.85	0.85	0.7	0.7	0.7	3	1.85	0.5	5	5	5	0.425	0.975	0.425	0.25	0.35	0.35	0.35	0.35	1.3	2.6	3.3	9.1		
Barium	60	520	80	89.3	518	463	126	181	423	149	53	93.5	162.5	95.25	172.5	166	177.25	188	177.5	194.75	378	193	187	190	210	141	491		
Beryllium	2.5	2.5	2.5	0.1	0.1	0.1	0.25	0.25	0.05	0.05	0.025	0.05	1.25	1.25	1.25	0.1625	0.245	0.05	0.125	0.125	0.025	0.315	0.025	0.05	0.6	0.8	2.2		
Cadmium	2.5	2.5	2.5	0.5	1.2	0.5	1.3	1.1	1.3	1.8	0.6	0.7	1.25	1.25	1.25	0.25	0.375	0.25	0.55	0.375	0.285	0.485	0.475	0.44	1.0	0.7	2.4		
Cyanide (Total)	2.5	7	2.5	5	5	5	5	3.85	2.35	2.35	3.5	0.7	1.25	1.25	1.25	2.5	2.5	2.5	2.5	1.925	1.175	1.175	1.175	0.7	2.7	1.7	6.0		
Chromium VI	5	5	5	5	5	5	5	5	5	5	5	5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3.5	1.3	6.1		
Lead	25	25	25	0.35	0.35	0.83	1.3	0.35	1.7	0.5	0.25	0.25	12.5	12.5	12.5	0.29	0.175	0.95	0.175	0.175	0.7	0.25	0.25	0.25	5.1	8.7	22		
Manganese	83	420	480	321	208	304	149	171	181	265	122.5	186.5	12.5	10	12.5	9.25	9.6	12.5	13.45	11.825	8.55	8.9	12.6	9.45	126	144	414		
Nickel	5	5	10	1.4	2.4	1.3	0.4	1.7	1.9	3.3	1.35	0.5	2.5	2.5	2.5	0.175	0.485	0.175	0.65	0.425	0.125	0.65	0.48	0.25	1.9	2.2	6.3		
Silver	5	5	5	0.2	0.48	0.2	0.2	0.2	0.2	0.325	0.225	2.5	7.5	7.5	2.5	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.225	1.3	2.1	5.6		
Tin	25	25	25	2.35	2.35	2.35	1.35	1.35	1	1	0.5	0.9	12.5	12.5	12.5	1.175	1.175	1.175	0.675	0.675	0.5	0.5	0.5	0.9	5.5	8.4	22		
Vanadium	25	25	25	0.2	1	0.2	0.25	0.25	0.92	0.2	0.5	0.2	12.5	12.5	12.5	0.1	0.2125	0.18	0.125	0.125	0.1	0.1	0.1	0.2	4.9	8.8	22		
Zinc	5	65	5	0.75																									

Notes:

<sup>1</sup> Concentrations for duplicate samples were averaged.

Concentrations in blue are actual detected values.

Concentrations in black are equivalent to one-half of the laboratory reported detection limit.



**TABLE E-2**  
**Analytical Results and Calculations**  
**for Background Surface Water Samples**

SAMPLE LOCATION	SW-1	SW-1	SW-1	SW-1	SW-1	SW-1	SW-1	SW-1	SW-1	SW-1	SW-1	SW-1	MEAN	ONE	TWO
ENVIRON SAMPLE ID	ECSW1-01	SW1-981207	ECSW1-02	SW1-990315	SW1-990415	ECSW1-03	SW1-990603	SW1-990614	SW1-990630	SW1-990714	SW1-000210	SW1-000309	CONCENTRATION	STANDARD	STANDARD
COLLECTION DATE	11/11/1998	12/7/1998	2/17/1999	3/15/1999	4/15/1999	5/13/1999	6/3/1999	6/14/1999	6/30/1999	7/14/1999	2/10/2000	3/9/2000	DEVIATION	DEVIATION	DEVIATIONS
COMMENTS <sup>1</sup>					DUPLICATE		DUPLICATE	DUPLICATE	DUPLICATE	DUPLICATE	DUPLICATE	DUPLICATE	OF MEAN	OF MEAN	ABOVE MEAN
<b>Volatile Organic Compounds</b>															
1,2-Dichloroethene (total)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	11	0.25	0.25	1.1	3.1	7.4
Ethylbenzene	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.25	0.25	0.25	0.27	0.1	0.42
Methylene Chloride	0.25	0.25	0.25	0.25	0.75	1	0.25	0.95	0.25	0.25	3	0.25	0.64	0.8	2.2
Tetrachloroethene	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	4	0.25	0.25	0.56	1.1	2.7
Toluene	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.6	0.25	0.225	0.28	0.1	0.48
1,1,1-Trichloroethane	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	6.5	0.25	0.25	0.77	1.8	4.4
1,1,2-Trichloroethane	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0.25
Trichloroethene	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	14	0.25	0.25	1.4	4.0	9.3
Vinyl Chloride	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0.25
<b>Semi-Volatile Organic Compounds</b>															
Bis (2-ethylhexyl) phthalate	5	5	1	4.5	5	5	5	5	5	5	4.75	4.75	4.6	1.1	6.9
1,2-Dichlorobenzene	5	5	5	4.5	5	5	5	5	5	5	4.75	4.75	4.9	0.2	5.2
Diethyl Phthalate	5	5	5	4.5	5	5	5	5	5	5	4.75	4.75	4.9	0.2	5.2
Di-n-butyl phthalate	5	5	5	4.5	5	5	5	5	5	5	4.75	4.75	4.9	0.2	5.2
Naphthalene	5	5	5	4.5	5	5	5	5	5	5	4.75	4.75	4.9	0.2	5.2
Phenol	5	5	5	4.5	5	5	5	5	5	5	4.75	4.75	4.9	0.2	5.2
<b>Polychlorinated biphenyls</b>															
Aroclor 1016	0.5	0.48	0.24	0.235	0.25	0.25	0.25	0.245	0.245	0.25	0.2425	0.25	0.3	0.1	0.5
Aroclor 1221	1	0.95	0.485	0.47	0.5	0.5	0.5	0.4875	0.4875	0.5	0.4825	0.5	0.6	0.2	0.9
Aroclor 1232	0.5	0.48	0.24	0.235	0.25	0.25	0.25	0.245	0.245	0.25	0.2425	0.25	0.3	0.1	0.5
Aroclor 1242	0.5	0.48	0.24	0.235	0.25	0.25	0.25	0.245	0.245	0.25	0.2425	0.25	0.3	0.1	0.5
Aroclor 1248	0.5	0.48	0.24	0.235	0.25	0.25	0.25	0.245	0.245	0.25	0.2425	0.25	0.3	0.1	0.5
Aroclor 1254	0.5	0.48	0.24	0.235	0.25	0.25	0.25	0.245	0.245	0.25	0.2425	0.25	0.3	0.1	0.5
Aroclor 1260	0.5	0.48	0.24	0.235	0.25	0.25	0.25	0.245	0.245	0.25	0.2425	0.25	0.3	0.1	0.5
<b>Inorganics</b>															
Arsenic	0.85	1.9	0.7	0.7	11.8	2.9	3	3.35	0.8	5.3	2.9	0.8	2.9	3.1	9.2
Cyanide (Total)	5	5	5	3.85	2.35	10.3	21.425	8.85	2.35	1.4	2.425	0.45	5.7	5.7	17
Chromium VI	5	5	5	5	5	5	5	5	5	5	114	15.7	15	31	78
Lead	0.35	0.35	1.6	2.4	29.15	0.5	0.5	1.6	0.5	0.5	4.15	0.5	3.5	8.2	20
Nickel	7.95	27.9	8.2	18	56.75	20.5	3.75	20.4	14.25	11.55	19.85	18.6	19	14	46
Zinc	0.75	11.2	3.8	27.8	175.9	14.2	4.1	18.65	6.15	29.65	23.3	0.25	26	48	123

**Notes:**

<sup>1</sup> Concentrations for duplicate samples were averaged.

Concentrations in blue are actual detected values.

Concentrations in black are equivalent to one-half of the laboratory reported detection limit.

**TABLE E-3**  
**Applicable Subsurface Water Background Concentrations**  
**ECC Superfund Site - Zionsville, Indiana**

Parameter	Acceptable Subsurface Water Concentration <sup>1</sup> (ug/L)	Applicable Subsurface Water Background Concentrations <sup>2</sup> (ug/L)	Applicable Subsurface Water Background Concentrations Exceeding The Acceptable Subsurface Water Concentrations (ug/L)
<b>Volatile Organic Compounds</b>			
Acetone	3,500	5.6	
1,1-Dichloroethene	7	1.8	
1,2-Dichloroethene (total)	70	1.7	
Ethylbenzene	680	1.7	
Methylene Chloride	4.7	133	133
Methyl Ethyl Ketone	170	8.0	
Methyl Isobutyl Ketone	1,750	8.0	
Tetrachloroethene	0.69	1.7 <sup>3</sup>	
Toluene	2,000	1.9	
1,1,1-Trichloroethane	200	1.7	
1,1,2-Trichloroethane	0.61	1.7 <sup>3</sup>	
Trichloroethene	5	1.8	
Vinyl Chloride	2	4.0 <sup>3</sup>	
Xylenes (total)	10,000	3.4	
<b>Semi-Volatile Organic Compounds</b>			
Bis (2-ethylhexyl) phthalate	2.5	7.3	7.3
Di-n-butyl Phthalate	3500	6.2	
1,2-Dichlorobenzene	600	6.2	
Diethyl Phthalate	28,000	6.2	
Isophorone	8.5	6.0	
Naphthalene	14,000	6.2	
Phenol	1,400	6.6	
<b>Inorganics</b>			
Antimony	14	15.6	15.6
Arsenic	50	9.1	
Barium	1,000	491	
Beryllium	4	2.2	
Cadmium	10	2.4	
Chromium VI	50	6.1	
Lead	50	22	
Manganese	7,000	414	
Nickel	150	6.3	
Silver	50	5.6	
Tin	21,000	22	
Vanadium	245	22	
Zinc	7,000	82	
Cyanide (total)	154	6.0	
<b>Polychlorinated biphenyls</b>			
Aroclor 1016	0.0045	0.6	0.6
Aroclor 1221	0.0045	1.1	1.1
Aroclor 1232	0.0045	0.6	0.6
Aroclor 1242	0.0045	0.6	0.6
Aroclor 1248	0.0045	0.6	0.6
Aroclor 1254	0.0045	0.6	0.6
Aroclor 1260	0.0045	0.6	0.6

**Notes:**

<sup>1</sup> Acceptable Subsurface Water Concentrations as presented in Revised Exhibit A, Table 3-1.

<sup>2</sup> Applicable Subsurface Water Background Concentrations are defined as two standard deviations above the calculated mean of the 12 background sample sets.

(i.e., Applicable Background Concentrations = Mean + (Standard Deviation \* 2))

<sup>3</sup> All values were non-detect.

**TABLE E-4**  
**Applicable Surface Water Background Concentrations**  
**ECC Superfund Site - Zionsville, Indiana**

Parameter	Acceptable Stream Concentration <sup>1</sup> (ug/L)	Applicable Surface Water Background Concentrations <sup>2</sup> (ug/L)	Applicable Surface Water Background Concentrations Exceeding The Acceptable Stream Concentrations (ug/L)
<b>Volatile Organic Compounds</b>			
1,2-Dichloroethene (total)	1.85	7.4	7.4
Ethylbenzene	3,280	0.4	
Methylene Chloride	15.7	2.2	
Tetrachloroethene	8.85	2.7	
Toluene	3,400	0.5	
1,1,1-Trichloroethane	5,280	4.4	
1,1,2-Trichloroethane	41.8	0.3	
Trichloroethene	80.7	9.3	
Vinyl Chloride	525	0.3	
<b>Semi-Volatile Organic Compounds</b>			
Bis (2-ethylhexyl) Phthalate	50,000	6.9	
Di-n-butyl Phthalate	154,000	5.2	
1,2-Dichlorobenzene	763	5.2	
Diethyl Phthalate	52,100	5.2	
Naphthalene	620	5.2	
Phenol	570	5.2	
<b>Inorganics</b>			
Arsenic	0.0175	9.2	9.2
Chromium VI	11	77.6	77.6
Lead	10	19.8	19.8
Nickel	100	46.3	
Zinc	47	123	123
Cyanide (total)	5.2	17.2	17.2
<b>Polychlorinated biphenyls</b>			
Aroclor 1016	0.000079	0.5	0.5
Aroclor 1221	0.000079	0.9	0.9
Aroclor 1232	0.000079	0.5	0.5
Aroclor 1242	0.000079	0.5	0.5
Aroclor 1248	0.000079	0.5	0.5
Aroclor 1254	0.000079	0.5	0.5
Aroclor 1260	0.000079	0.5	0.5

**Notes:**

<sup>1</sup> Acceptable Stream Concentrations as presented in Revised Exhibit A, Table 3-1.

<sup>2</sup> Applicable Surface Water Background Concentrations are defined as two standard deviations above the calculated mean of the 12 background sample sets. (i.e., Applicable Background Concentrations = Mean + (Standard Deviation \* 2))